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THE NEW STATE CAPITOL AT HARTFORD, CONN.

It is curious to note how the course of architecture in this country has closely followed the changes in the art developed in Europe and more especially in England. The severe Roman classical style of the last century became supplanted in the Greek revival of 1762, and in both Great Britain and the United States appeared buildings in the main reproductive of ancient Hellenic temples. The British Museum in London, and our own public buildings in Washington, besides numerous custom houses, hotels, and banks, are types of more imposing edifices erected in the Greek style; while scores of wooden country dwellings in almost every village in the Eastern States attest, by their heavy pillars and broad porches, the predilection of architects for its use wherever possible. As the Roman has failed before the Greek, so has the latter in no small measure become less popular than the Gothic, the revival of which style may be fairly dated as of fifty years ago. Fostered by progress in archæological studies and by ecclesiastical patronage, the mediæval in art grew steadily in favor; and as a result, an almost new order of architecture,the modern secular Gothic, sprang into existence, which, emancipating itself from purely religious application, has reformed the very principles of the original designs. To Ruskin is ascribed this change, and Eastlake says that it was reserved for him "to strike a chord of human sympathy that vibrated through all hearts, and to advocate, independently of considerations which had hitherto only enlisted the sympathy of a few, those principles of mediæval art whose application should be universal."

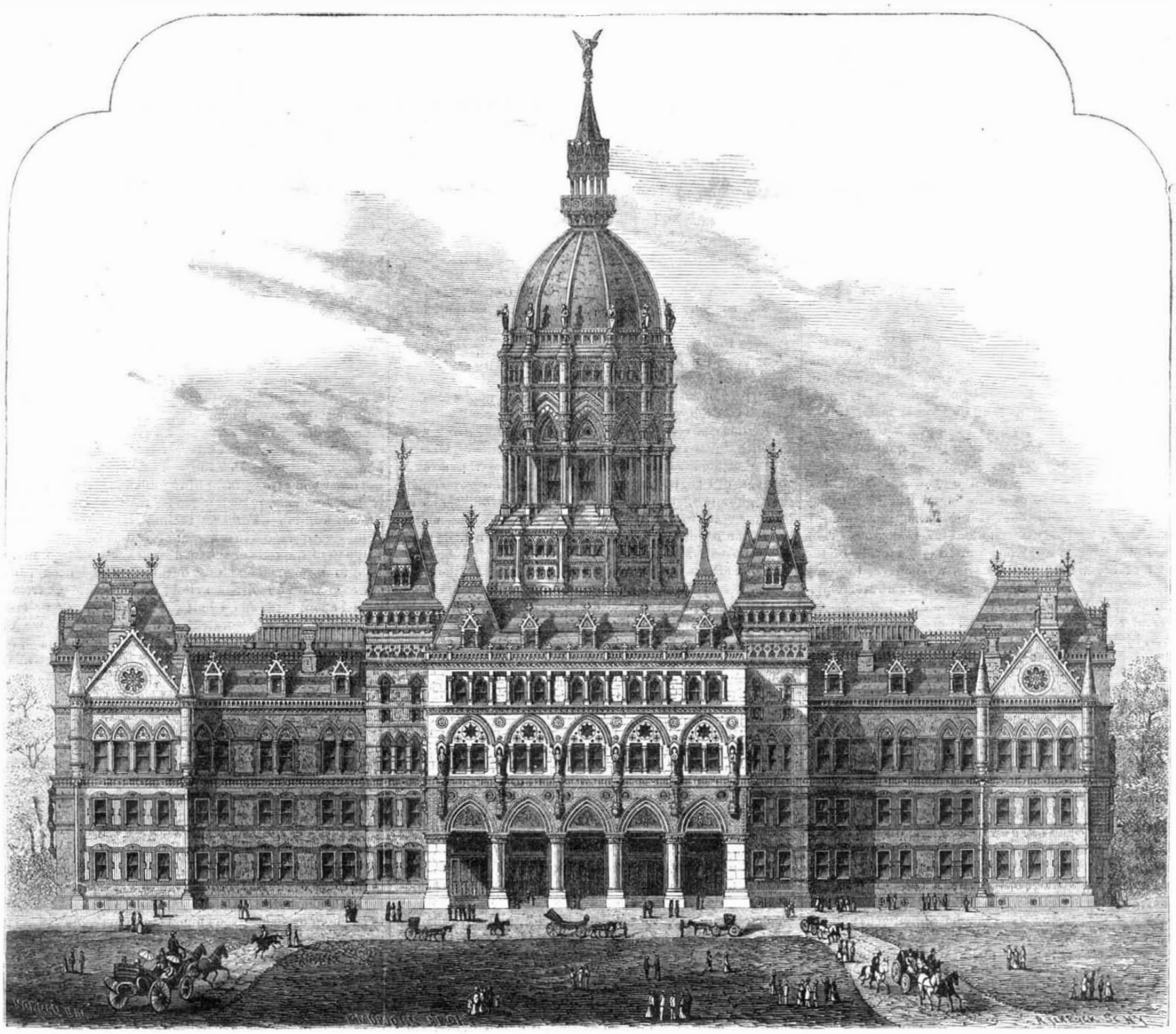
With this brief review of the origin of the secular Gothic in architecture, we lay before our readers a fine engraving of an edifice which, when completed, will probably be the most prominent and striking example of the style as treated in the United States. It is the State Capitol of Connecticut, and is located in the City Park, a tract of some 40 acres, in the city of Hartford. The site is on elevated ground, is commanding and appropriate, and admirably suited to display the fine design of the structure. The central feature is the dome, which, springing to a hight of two hundred and fifty feet above the ground, is surmounted by a colossal female figure, representing Connecticut, holding in her hand the original charter of the State. In common with the entire edifice, the dome is of white marble and richly adorned with arcades, columns, galleries, and with thirteen figures placed one at each terminal at angles, each statue supporting a shield bearing the arms of one of the original States. The dome in plan is a dodecagon 56 feet in diameter, and is flanked by towers 160 feet in hight.

The extreme length of the main building is 300 feet and its greatest depth 200 feet. Its construction is of the most substantial description, iron beams and brick arches, and also ground arches in brick filled in, being used throughout. The main entrances are on the north and south fronts,having vestibules, and leading through arcaded openings. In the tympani of the arches over the grand entrance, are five bas reliefs representing Putnam leaving his plow, and his celebrated horseback ride down the steps, the charter oak, the landing of the pilgrims, and the surrender of Cornwallis. On the front of the building above the main door are twenty-six niches destined for large statues, and suitable places are provided over all the entrances for the reception of busts of distinguished men. These decorations and the handsome slate roof, together with the general ornate type of the building, will render it,if we may judge from the finished drawings of the elevation, one of the most artistically beautiful structures ever erected. The lower and third floors are devoted to offices and apartments for state and other officials. The second floor contains the Halls of the Senate and Representatives, the Supreme Court, and the Library. The Representatives' Hall is in the central building of the front, is lighted on three sides, and is supported on arcades of polished granite columns, with capitals elegantly carved in marble. The library has two stories of windows, and of alcoves for books.

The main hall, which is approached by all entrances,is tiled and has a stone colonnade, supporting the groined ceiling and floor above. It is well lighted from the doorways and the corridors at each end. There are two grand staircases, entirely of stone and of very massive and beautiful design.

Mr. R. M. Upjohn, of this city, the designer of St. Thomas' Church on Fifth avenue and many other prominent buildings throughout the country, is the architect. He informs us that the ground floor of the structure is now completed and that the entire edifice will require about three years to finish.

GOLD melts at 2,590° Fah.—a little above the melting point of copper.



NEW STATE CAPITOL AT HARTFORD, CONN.

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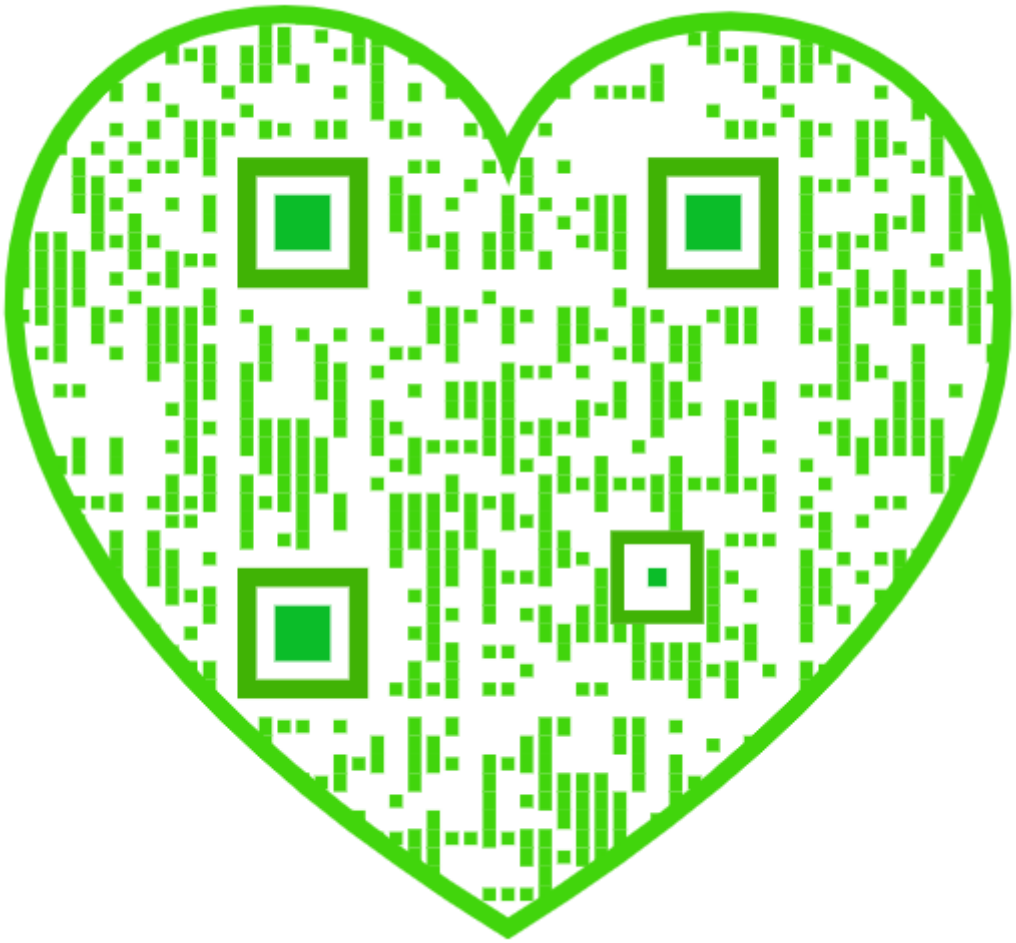

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THE VIENNA EXHIBITION AND ITS RESULTS.

The Vienna Exhibition closed November 1 last, and that wonderful display of industrial products, which had been gathered with so much toil, and at such expense of time and money, from every quarter of the globe, has been broken up, and its exhibits are now scattered as widely as before their collection. The greatest of international exhibitions has become a thing of the past. Its influence, however, remains and will long be felt in every part of the world. Even on our side of the Atlantic, thousands of miles from the strange, busy scene in which we, of all civilized nations, took least part, we feel that, in some respects, we have been benefitted by the most important and most creditable of all Austrian enterprises.

We felt it our duty to warn the public of the risks which were to be met by those who proposed to take into Austria valuable inventions. We considered the defective patent code of that country no safeguard to inventors, and showed that, despite the promises—still unfulfilled—of liberal changes, any really valuable improvement would be likely to be pirated, unless, as could seldom be the case, the exactions of the law were fully complied with. These facts were so well exhibited that but few of our great inventions were seen at Vienna, and the United States section became conspicuous for its small extent; and our own people, visiting the *Ausstellung*, were struck with the barrenness of the American department. We were, however, well represented in quality, if not in quantity; and if we may judge from the official record of awards, the jury was very favorably impressed. The proportion borne by the number of awards of Medals of Progress to the number of Medals of Merit granted, as well as the large proportion of awards made to our small number of exhibitors, are both high, in Group XIII (machinery). The medals are nominally of equal value, but the second class mentioned are given for abstract merit, while the first named were given only where merit was accompanied by evidence of a substantial and meritorious advance, effected since the date of the Paris Exposition, in devices deemed specially meritorious at that time. The United States brought away one third more medals of the first than of the second kind, and is, we believe, the only nation in which the comparison does not give a reverse proportion.

The real results of this enterprize are properly gaged, however, by a broader view than this. The distribution of medals is but an incident of the grand work. Comparatively few of the exhibits taken to Vienna by our people will be brought back to the United States. They have found purchasers from all parts of the world, and go among strangers, civilized and uncivilized, to spread abroad the fame of American mechanics and Yankee inventions. Our sewing machines are distributed from St. Petersburg to Calcutta, and our agricultural implements are found in every grain raising district from Great Britain to China, and our wood and metal working tools are almost as familiar to the Hungarian and the Bohemian as to our own mechanics. In the Chinese and Japanese sections, even, it was noticed very early in the season that nearly every article was marked *verkauft* (sold) and the unique productions of the Orientals thus also become distributed throughout the world. From the farthest east, from north and south and west, the most intelligent and the most enterprising of every nation have met to see what others have accomplished, and to learn whatever may most aid their own advancement.

It is this universal dissemination of the acquired knowledge of every department of industry that constitutes the most important work of an international exhibition. Bringing together, as it does, the products of the labor of every nation, and displaying the natural resources of every country to all who can purchase the one or who can develope or utilize the other, bringing the nations of every part of the globe into close communion, and presenting to all the best fruits of the labors of each, the most advanced and most thoroughly civilized are stimulated by competition to greater exertions, and to the accomplishment of still nobler results; while those countries which are farthest behind in the great march of human progress are taught what has been done by others, and are awakened and urged to make an earnest effort to overtake those who are now so far in advance of them. All are taught that nations, like individuals, may choose between poverty and competence, if not affluence, and that intelligence, honesty, industry, and frugality invariably bring their reward.

Now that the Austrian Exhibition of 1873 has become one of the great bygones, we look forward with renewed zeal to the successful inauguration of our own coming Centennial International Exhibition of 1876. The time for preparation is none too ample, and we anticipate with anxious as well as hopeful interest the opening of its

"* * * * * * * long laborious miles
Of palaces; lo! the giant aisles
Rich in model and design,
Harvest tools and husbandry,
Loom and wheel and enginery,
Secrets of the sullen mine,
Steel and gold, and corn and wine,
Fabric rough or fairy fine,
Sunny tokens of the line,
Polar marvels, and a feast
Of wonder out of West and East,
And shapes and hues of part divine
All of beauty, all of use,
That one fair planet can produce,
Brought from under every star,
Blown from over every main,
And mixed, as life is mixed with pain,
The works of peace with works of war.

PATENT OFFICE PRINTING.

A correspondent of the New York *World*, writing to that paper from Washington, gives some items of public printing done by the Congressional Printer, among which is the sum of $142,793 charged for Patent Office printing. On this the writer complains in the following style:

"I selected the Patent Office from the Interior Department for this reason: the work done for that institution is not paid for by taxes, but by the people that take out patents. It is the people's money, not the Administration's, and in justice the work should be let out to the lowest bidder after advertisement. In this item 25 per cent, if not more, could be saved. In this connection the Government is running a monthly periodical for $1 a year, called the *Official Gazette*, a most flagrant abuse of public confidence and rather a small business for a government spending its $300,000,000 a year to engage in."

We fail to perceive where the "flagrant abuse of public confidence" would come in, even if it were true that the *Official Gazette* were a monthly periodical run at $1 a year. Unfortunately it is not true. The price is $6 a year, and it is published weekly. The publication is, however, carried on at a heavy expense to the government; but as it has been expressly ordered by Congress, the Commissioner of Patents only discharges his simple duty in attending to its publication, and the manner in which the work is produced is highly creditable to him. The *Official Gazette* takes the place of the former annual volumes, known as the Patent Office Reports, on which Congress was accustomed to spend far more than the weekly *Gazette* costs.

The Patent Reports were printed for free distribution by members of Congress, and the same practice is substantially maintained in respect to the *Gazette*. The public demand for it is far from sufficient to pay its support.

Ten thousand copies of the *Gazette* are printed every week, of which three thousand copies go to subscribers, who pay $6 a year, and seven thousand copies are given away to members of Congress, other departments of the government, courts, libraries, etc. The total cost of the publication is not far from sixty-four thousand dollars a year. The annual loss to the government by the publication, is a little under fifty thousand dollars a year.

Prior to the establishment of the *Official Gazette*, the patent claims were published in the SCIENTIFIC AMERICAN, and our publication of them was a matter of great convenience and advantage to the Patent Office. On the basis of the amount now paid out by the government for similar work, our publication of the claims must have saved the Patent Office from twenty to forty thousand dollars a year, during a period of nearly twenty years. But we never received a single centaro from the Patent Office for the service; indeed we could never prevail upon the department to be so liberal as to furnish us with a free copy of the claims for our printers to set up the types. On the contrary, we were compelled to pay the Patent Office from five hundred to a thousand dollars a year to furnish us with the copy. After the issue of our paper, the Patent Office was then accustomed to expend a few cents weekly in purchasing extra copies of the SCIENTIFIC AMERICAN, out of which it scissored the printed claims for use in the various examiners rooms, and in connection with the drawings, and the preparation of the annual reports.

The weekly publication of the claims is desirable as a matter of convenience, to the Patent Office, and to a limited number of persons, consisting mostly of patent agents and attorneys. But the public in general have little use therefor. We believe it would be a much better plan to enlarge the *Gazette* so as to give the specifications and drawings in full of all patents issued. This would form an invaluable work of great importance to the public, and, if issued at, say, $25 a year, would doubtless be self-supporting, provided the free list were wholly suspended, and the best economy practiced in the printing.

SCIENCE RECORD FOR 1874.

The new volume of this work is now upon the press, and will be ready for delivery about the 20th of January. The forthcoming book is one of unusual interest and value. It embraces a condensed account of the leading discoveries and improvements in the various branches of science, including Chemistry, Metallurgy, Mechanics, Engineering, Electricity Light, Heat, Sound, Technology, Pisciculture, Botany, Horticulture, Agriculture, Rural and Household Economy, Materia Medica, Therapeutics, Hygiene, Natural History, Zöology, Meteorology, Terrestrial Physics, Geography, Geology, Mineralogy, Astronomy, Biography, etc.

The various departments are illustrated with suitable engravings. In Metallurgy, for example, we have illustrations of Siemens' furnace and a description of his new and successful method of making iron and steel direct from the ore. This is accomplished at a cost of from 20 to 50 per cent less than by the present blast furnaces. The subject is of importance to iron workers. In Mechanics and Engineering, we have accounts of new railway improvements, novel machines, and a great variety of new devices. Technology is full of new information, and there is hardly a worker in any branch of the applied arts, but will here find some new hint, recipe, or suggestion, of more worth to him than many times the cost of the book. In Agriculture, we have accounts of new methods for preparing manures with economy, improvements in treating soils, new and useful plants and vegetables. Among the latter is illustrated a new and early variety of the potato, from which six hundred pounds are raised for every pound of seed planted, a most valuable acquisition for all who maintain gardens. Natural History, Zöology, Pisciculture, all are full of interest. Portraits of prominent scientific men and discoverers are given, among which we notice those of Liebig, Draper, Proctor, Lockyer, Baker. The miscellaneous department will be found especially attractive and useful. Here we have a series of engravings illustrating the various devices employed to assist learners in drawing. Among these is a new reflecting drawing board, which, by means of a simple pane of glass, throws down upon the paper the outline of the picture that is to be copied. Then we have the pentagraph, the perspective rulers, sketching frames, reducing and copying glasses. All are so described as to enable any person of intelligence, to make and use the several instruments. This series of engravings, with the practical instructions given for drawing, will greatly facilitate and encourage all persons, old or young, who wish to acquire the art of drawing. Not only are the various instruments shown, but their manner of use in actual practice is illustrated. *Science Record* for 1874 forms a handsome octavo volume of 600 pages, nicely bound, uniform with previous issues. Price $2.50. Published by Munn & Co., 37 Park Row, N. Y., and by them sent everywhere on receipt of price. May be ordered through any book or news store.

THE VALUE OF A KERNEL OF CORN.

In considering the curious and interesting chemical nature of corn, we shall use the word as applied to wheat, as well as to maize. The two grains are chemically constituted very much alike, and what may be said of one applies with almost equal truth to the other. Both are made up of starch, dextrin, gum, sugar, gluten, albumen, and phosphates of lime, magnesia, and potassa, with silica and iron. Wheat contains about double the amount of lime and iron, and considerable more phosphoric acid, but less magnesia and soda. The maize seeds are rich in a peculiar oil, which is nourishing and highly conducive to the formation of adipose or fatty matter; hence, the high utility of corn in fattening animals. What a remarkable combination of chemical substances is stored up in a kernel of corn? It may almost be said to be an apothecary's shop in miniature; and the order and arrangement of the mineral elements and vegetable compounds, needed to render the comparison more apt, are not wanting. For some reason, Nature places the most valuable substances in a kernel nearest the air and sunlight, while the little cells of the interior are full of the material used to keep erect and tidy our collars and neck bands—starch. With a moistened cloth, we can rub off from the kernel about three and a half per cent of woody or strawy material, of not much nutritive value; and then we come to a coating which holds nearly all the iron, potash, soda, lime, phosphoric acid and the rich nitrogenous ingredients. This wrapper is the storehouse upon whose shelves are deposited the mineral and vegetable wealth of the berry. Whence come these chemical agents? By what superlative cunning are they grouped within the embrace of this covering? They come of course from the soil; and by the mysterious and silent power of vital force, they have been raised, atom by atom, from their low estate, and fitted to perform the high offices of nutrition in the animal organisms. And should we not appropriate them to our use as the most carefully adjusted of all materials designed for human aliment? Certainly we should; but do we? Unfortunately we cannot render an affirmative answer. The sharp teeth of our burr mills drive ruthlessly through the rich wrappers of the kernel, and then torn fragments pass to the bolt, and from that to the barn or stable; the animals obtain the nutritious gluten, and the starch, in the form of fine flour, is set aside for family use. But it is not designed to enlarge upon this point. Let us look at the chemical offices the substances found in the kernel of corn subserve in the animal economy.

Starch is the wood or coal which, under the influence of oxygen, is to be consumed or burned to maintain animal warmth. It passes in as pure fuel, it is oxydized, and the ashes rejected through the respiratory organs. The warmth imparted by this combustion is necessary to the proper ful-

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filment of the functions of the body. Of these functions, those of digestion and assimilation are the most important. The digestive apparatus receives the gluten and the starch of the grain; the latter is pushed forward to be burned, the former enters the circulation; and out of its contained iron, potash, soda, magnesia, lime, nitrogen, etc., are manufactured all the important tissues and organs of the body. All of the iron is retained in the blood, together with much of the soda and phosphoric acid; the lime goes to the bones, and the magnesia very abruptly leaves the body, as it seems to be very plainly told that it is not wanted. Such, in brief, are the uses which the organic and inorganic constituents of a kernel of corn subserve in the chemistry of animal life.

The changes which they are made to undergo in the laboratory are almost equally interesting and important. Fecula, or starch, is a body of great interest, and is not found alone in corn. There is scarcely a plant or part of a plant which does not yield more or less of this substance. What a curious vegetable is the potato! Swollen or puffed out by the enormous distention of the cellular tissue in which the starch is contained, it seems almost ugly in its deformity. It is little less than a mass of starch when the watery part has been evaporated.

If we separate the starch from the gluten in corn, and boil it a few minutes with weak sulphuric acid, it undergoes a remarkable change, and becomes as fluid and limpid as water; and if we withdraw the acid, and evaporate to dryness, we have a new body, a kind of gum called dextrin. But if we do not interrupt the boiling when it becomes thin and clear, but continue it for several hours, and then withdraw the acid by chemical means, we have remaining a liquid, very sweet to the taste, which will, if allowed to separate, solidify to a mass of grape sugar. This is the method of changing corn into sirup and sugar. What is most extraordinary in this process is the fact that the acid undergoes no diminution or change. The play of chemical affinities lies between the amidine and the elements of water, grape sugar containing more oxygen and hydrogen, compared with the quantity of carbon, than the starch. Nothing can be more striking than these changes. From the kernel of corn we obtain starch, this we change easily into gum, and, by the aid of one of the most powerful and destructive acids, transform it into sirup and sugar.

We are now to consider another most extraordinary change which corn is capable of undergoing, that of being transformed into whiskey or alcohol. If we take the sweet liquid obtained by the infusion of malted corn, and subject it to a temperature of 60° or 70° Fah., it soon becomes turbid and muddy; bubbles of gas are seen to rise from all parts of the liquid, the temperature rises, and there are signs of chemical action going on in it. After a while, it slackens and soon stops altogether. Examination shows that it has now completely lost its sweet taste, and acquired another quite distinct. An intoxicating liquid is found, and if we place it in a still, we obtain a colorless, inflammable liquid, easily recognized as alcohol. By a peculiar arrangement of the condensing apparatus of the still, a portion of the grain, oils, and a large amount of water are allowed to go over with the alcohol, and this constitutes whiskey.

This is an example of the change called vinous fermentation. The influence of a ferment or decomposing azotized body upon sugar is strange and quite incomprehensible. Through its agency, we may cause the highly organized kernel of corn to take another step downward towards a dead inorganic condition. We can transform the alcohol over into acetic acid or vinegar, or the sugar may be formed into one of the most curious organic acids, the lactic. As in these processes, we follow the kernel of corn through the various changes, first into gum, then into sugar, then alcohol, then vinegar, and ultimately into carbonic acid and water, we obtain an imperfect idea of the marvels of vital chemistry. The chemistry of a kernel of corn is a comprehensive topic, and to be considered even in its outlines would supply material sufficient for a volume. The aim has been to group together a few of the most interesting points, and thus awaken a desire for a more complete and satisfactory investigation.

THE PRIME MOVERS AND THEIR RECENT PROGRESS.

The prime movers remaining unconsidered in our last issue are the heat engines. It was first pointed out by Benjamin Thompson, of New Hampshire, whose fame was won abroad at about the time of the war of the Revolution, and who was made Count Rumford in Europe, that heat was not a substance, as had been previously supposed, but that it was a kind of motion. In his paper, published by the Royal Society in 1798, he described experiments which not only proved this now well known and universally admitted fact, but also furnished *data* for estimating very closely the value of the "mechanical equivalent" of a unit of heat.* Sir Humphrey Davy, whose attention may have been called to the subject by Rumford's paper, in the following year made his celebrated corroborative experiment, melting ice, in an atmosphere below the freezing temperature, by friction, and published his acquiescence in the dynamic theory, becoming one of the earliest disciples of Rumford. Subsequently, the beautiful method of Mayer and the excellent work of Joule determined with precision the fact that the heat energy of a British thermal unit has an equivalent in mechanical power whose measure is 772 pounds raised one foot high. In heat engines, it is impossible to obtain all of this power from the heat obtainable from any source. If coal is burned, the heat developed becomes wasted, to a certain extent, in transmission to the prime mover, and a very large quantity is lost in the machine itself in many ways which have been already explained in these columns. It thus happens that, while the heat obtained from a pound of coal should do work equivalent to raising a pound weight to a hight of two thousand miles, our engines are so imperfect that our best builders decline to guarantee a tenth of this duty with even very large engines of the most perfect known design. In an editorial article, published in the SCIENTIFIC AMERICAN, January 11, 1873, we exhibited the reasons for this serious waste of power, and showed how far improvement is possible in heat engines working on known principles, and that the range of increased efficiency left to be effected by this improvement amounts to about 15 per cent in the engine and 30 per cent in the boiler of the steam engine, when working between the present limits of temperature. It is impossible to fix a limit to the gain by elevation of temperature and pressure and increased expansion.

We can record no important advance in steam engineering since that date. The use of the compound engine is becoming more general, and progress in the direction of higher steam pressure, and greater expansion is causing gradual modification of old forms of boilers to meet safely the higher pressures and the so-called "safety" or "sectional" boilers are coming into use still more extensively in consequence of this change. No great improvement has been recently effected either at home or abroad. In Europe, as was stated in the letters of our Vienna correspondent, the practice in steam engines is passing through the same phase of experiment and revolution which was witnessed in this country fifteen years ago in the period of the great contests of Sickles and Corliss for supremacy in the then just opening field.

To-day a pound and a half of coal per horse power per hour represents the highest economy of the best classes of large engines; and for ordinary sizes, such as drive our mills and our workshop machinery, double that expenditure is not considered extravagant. We can only hope to see these figures greatly reduced by some now unimagined and complete revolution in engineering. Such a revolution is by no means impossible or perhaps even improbable, and it would be unwise to neglect any suggestion which looks promisingly toward such an inestimably important advance.

The immediate and well known directions in which engineers are seeking to improve the steam engines look to the prevention of external losses of heat by radiation and conduction, and to the reduction of internal losses due to cooling of the steam cylinder and to condensation of the prime steam, or to liquefaction by expansion and re-evaporation during the exhaust.

The first is accomplished very thoroughly by means of the many sorts of excellent "felting" now in the market, and by "lagging." The second is secured by superheating and by mixture of steam with air to a slight extent in non-condensing engines, and by the adoption of the "compound" engine, invented by Wolff a half century or more ago, long before the use of high steam and great expansion gave it its proper field.

Attempts have been frequently made, and a very promising one has been chronicled in our columns during the past year, to save and utilize the exhaust heat of the non-condensing steam engine, by applying it to the evaporation of some very volatile liquid, which is then applied to a supplementary engine. The real competition here lies between these "binary vapor" engines and the common condensing engine. The former would seem the more economical, and we are awaiting with interest the report of the performance of the engine which, it has been stated by the inventor, Mr. Ellis, is to be designed and tested by one of our most distinguished engineers. As we have already had occasion to remark, the effort to improve this class of prime movers is required to be exerted rather in removing the objections of the expense of the secondary fluid, the danger of loss by leakage, and the infinite annoyance, and generally the danger also, which attends its escape. These difficulties removed, a simple, durable, and properly designed machine of this class will find a ready market and will mark a decided advance, if in first cost and expense of maintenance it can compete successfully with the steam engine. Remembering that the economical value of a fluid depends simply upon the effectiveness with which it acts as a storehouse—a reservoir—of heat, and the advantages which it presents as a receiver and a dispenser of that heat, and remembering also that the mechanical effect depends just as much upon the volume as well as the density, upon the distance through which its pressure is exerted as well as upon the amount of that pressure, we can see that the value of any fluid as a medium of power transmission is not measured simply by its pressure at any given temperature. Up to the present time the vapor of water has been found, all things considered, the best single fluid for use in heat engines.

Air has been used very frequently in the production of power in heat engines, but it has not yet become a really successful and satisfactory motor. The convenience of obtaining an ample supply of air, its freedom from liability to produce destructive explosions, and the completeness of its expansive action, are important advantages, but they seem to be more than compensated by the difficulty of managing the fluid at the very high temperature at which it must be worked, the bulk and cost of construction and maintenance of the engine, and by difficulties, inherent in all known designs, of obtaining prompt and complete conveyance of heat into and out of the mass of air employed. Sixty years ago Dr. Robert Stirling proposed to use air in a heat engine, and his crude design was improved by James Stirling, who worked at the problem twenty years later. Our distinguished fellow citizen, Ericsson, still later, and nearly a quarter of century ago, designed a form of engine which was so successful that it still continues in use, as subsequently improved by its inventor. Shaw's engine and that of Rope have also met with some success; and the very promising engine of Wilcox, when just seeming most successful, disappeared, for reasons to us unknown. The superheated air engine of Leavitt is the latest example of this class which has come to our notice, but we now hear nothing more of that. At present, we see nothing specially noteworthy in this field of invention. We have indicated the difficulties of the problem, and leave the matter in the hands and minds of the ingenious and experienced mechanics who read our paper, and hope that we may yet be called upon to record the performance of an engine which shall produce the horse power for the expenditure of a pound of coal per hour, as is said already to have been done, and without burning itself out after a few weeks of good work. A "furnace gas engine," or one which uses in its cylinder the products of combustion, will probably prove the most economical form.

Gas engines are another class of prime movers from which much has been expected, but with which little success has been yet obtained. They offer nearly all the advantages of air engines, with the additional one of readily obtaining high pressure; but possess disadvantages peculiar to themselves which have, as yet, effectually prevented their introduction to any considerable extent. The first engine which came prominently before the public, the Lenoir engine, awakened much interest both among engineers and with the public. Using an explosive mixture, fired by electricity, the pressure was irregular, the engine noisy and wasteful of power, and the voltaic battery was a troublesome and costly appendage. The later use of a much smaller battery and the spark of the inductorium reduced but has not eliminated these objections. The Hugon engine next came into notice, and in this machine, by igniting the charge by means of an ingeniously arranged gas jet, this great objection to the use of exploding gases was done away with. In both these engines, the machine itself was quite similar in its details to the ordinary steam engine. The Otto and Langen engine, recently introduced abroad and noticed in our Vienna correspondence last summer, acts much like a Cornish pumping engine. The explosion of the gas drives the heavily loaded piston rapidly to the top of the cylinder, and, as it descends, its weight exerts a useful power. It is economical, using scarcely half the gas required by the earlier engines, but it is more rattling and irregular in its action than even they were. The most recent gas engine is, we believe, that of Brayton, in which explosion is avoided and of which, it is claimed, the economy equals that last mentioned. It seems a most promising invention, and we hope that time will prove its claims well founded. A good gas engine will find a large market. Its motion must be steady, its gases should be gradually burned instead of exploded, and it should not be injured by the high temperature of the products of combustion, nor should it be subject to rapid deterioration by wear or by any other cause.

We have but superficially glanced over this vast and important field, and have laid before our readers the present situation as respects the progress of the prime movers. Were not our limits so restricted, we should readily find much more to write on this subject, but we hope that we have at least set some active and fruitful brains and some experienced and skillful hands on the right track in a work of the highest importance to mankind.

We do not expect soon to see steam superseded, but we do anticipate that other motors will share the field with it to a far greater extent than has been yet the case, and we also are very greatly disinclined to believe that the steam engine itself has even approached the limit of its development.

*Professor Tait estimates this value, from Rumford's *data*, at within 20 per cent of the true value, and Professor Thurston, using a more correct measure of the horse power, estimates it at 784 foot pounds, or within about 1½ per cent of the value now accepted—772 foot pounds.

OBITUARY.

Jephtha A. Wilkinson.

The last day of the last year brought to a close the eventful life of this venerable and vigorous man. Born in Providence, R. I., at a very early age he exhibited a singular mental activity in the form of what is now popularly termed "go-ahead-itiveness." He was always engaged in driving forward some striking enterprise. He served in the war of 1812. Invented a machine for making weaver's reeds, was one of the first inventors of repeating fire arms and cannon also of the planing machine and of the rotary printing press He was a man of great intelligence and remarkable memory. He passed away in the 83d year of his age.

Lloyd A. Williams.

Lloyd A. Williams, late Chief Engineer in the navy, died recently at his residence on Rood street, Georgetown, D. C., in the forty-second year of his age. Chief Engineer Williams was a native of Washington, and entered the service of the United States on the 16th of February, 1852. His total sea service was eight years and five months. His last cruise was on the Colorado, which arrived at the Portsmouth, N. H., navy yard in June, 1872. During this cruise he contracted rheumatism, while in the Gulf of Mexico, from which disease he suffered greatly, and retired in consequence shortly after, in conformity with the act of August 3, 1861.

Draper Ruggles.

Draper Ruggles, of the firm of Ruggles, Nourse & Mason, predecessors of the Ames Plow Company (thirty years ago), in making agricultural implements at Worcester, died a few days ago, aged seventy-four.

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IMPROVED TRAMWAY AND VEHICLE.

We illustrate herewith an improved system of tramway, with a vehicle of peculiar construction, adapted for travel thereon. The inventor considers that his plan is applicable wherever the land transportation of heavy freight off of regular railroads is necessary, and for the running of stage coaches, etc. He believes it absurd to attempt giving a road a hard smooth surface, twenty to thirty feet in width, when but a few inches is required for the tread of the wheels. Moreover, any track reasonably hard and smooth, for the passage of the wheels of laden carriages, is unfit for the travel of horses, since in such case a yielding surface is required.

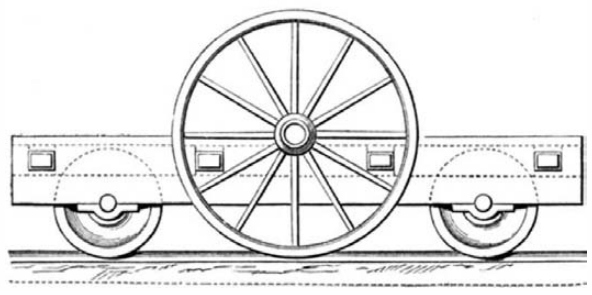
In the tramway herewith represented a longitudinal timber is simply bedded in the earth, even with the surface, and capped with a hard wood or metal rail. Each length is joined by iron sockets. It is stated that an oak or maple rail, sawn 2x4 inches, should last many years, but would require to be renewed several times before the bed timbers would be decayed. These, if of cedar, would be sound after 25 to 30 years' use.

The arrangement of cars proposed is as shown in Fig. 2. They are provided with two double flanged wheels, which may be constructed of wood sectors, having thin plate iron rims bolted or riveted to their sides. An iron arbor or axle passes through the center of the wheel, and is secured with flanges and nuts on each side, firmly screwed up. The outside courses of plank should be one inch in thickness, and project the same all around. Then the wheel is placed in a lathe and its periphery turned and trued up, making the edges of the outside courses form the flanges. A wheel thus constructed, of sound well seasoned oak or maple, will be good and durable, and will wear the track but little. Cast iron wheels should be used to run upon iron edged rails.

Each car needs a common carriage axle and wheels, bolted across for preserving its equilibrium. All should be proportioned so that these wheels should be within a few inches of the surface.

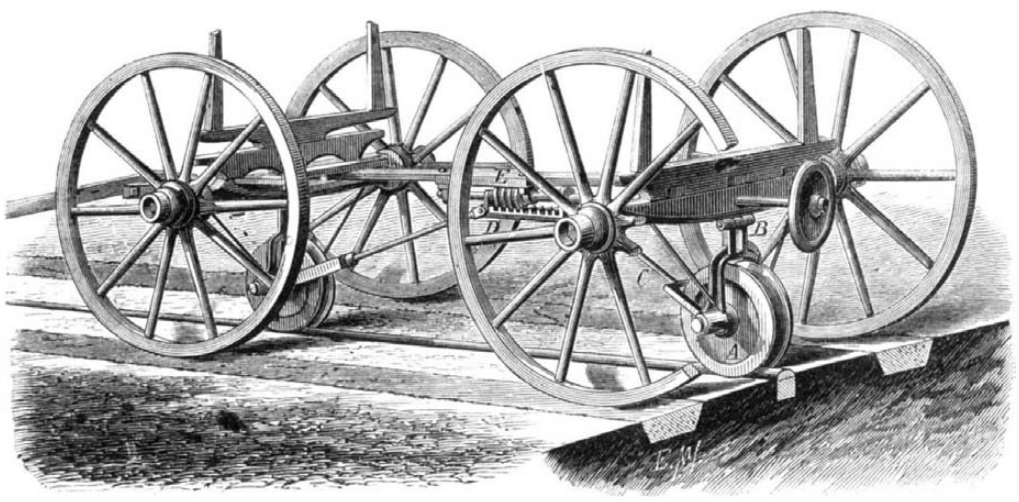
The inventor estimates the expense for these tramways, to be laid down on ordinary country roads, where no grading is required, as follows, per mile: 264 cedar logs, 20 feet, at 10 cents each, $26.40; 3,520 feet maple at $20 per M., $70.40; 1,700 lbs. cast sockets, at 3 cents, $52.80; 200 lbs. spikes, at 8 cents, $16; labor in laying and construction, $75. Total, $240.60. Such a road, it is stated, could be laid down for about $180 per mile by dispensing with iron sockets, etc. Trains of loaded wagons, whether propelled by horses or locomotive or traction engines, could be run over at a cost for transportation much less, the inventor claims, than by any other style of rail, tram, or common roads.

Fig. 2



All ordinary vehicles, stage coaches, lumber wagons, etc., are easily adapted to run upon these tramways, by means of the device shown in Fig. 1. A are the double flanged wheels, which travel upon the central rail, and are supported in hinged frames, B. To the latter are connected shafts, C, which are suitably secured to the rack, D. In the teeth of the latter engages the worm, E, the shaft of which extends to the rear of the vehicle, and terminates in the hand wheel shown. By turning the latter the central wheels, A, may be swung up clear of the ground, or may be let down upon the rail to sustain the main weight, while the outer wheels serve to balance the apparatus. The track for the carriage wheels consists in gutters filled with broken stone, so as to form an even and level surface. For stage coaches and similar vehicles, the shaft and hand wheel for adjusting the central wheels should be carried to the driver's seat for convenience. Patented July 25, 1871, through the Scientific American Patent Agency, by Mr. James F. Cass, of L'Original, Ontario, Canada, to whom inquiries for further particulars may be addressed.

Fig. 1



CASS' TRAMWAY AND VEHICLE.

A Curious Law Suit.

The Philadelphia *Ledger* gives the following account of a suit at law recently terminated in that city:

Two mill owners on the Wissahickon creek, above Chesnut Hill, engaged in a curious law suit, which was decided last week at Norristown. The mills are three quarters of a mile apart, and the stream between them has not much fall. In 1823, the owner of the upper mill brought suit against the owner of the lower mill for having backed the water into the race course of the upper mill. Under a decree of the court, the sheriff put up four permanent marks to establish the lawful surface of the water. At two places holes were drilled in fixed rocks, a marble stone was set in the tail race of the upper dam and properly marked, and a pin was driven into a buttonwood tree just thirty-one inches above the surface at the breast of the dam. The mills have changed owners since that time, but recently the race of the upper mill has been overflowed by back water, and the owner brought suit for damages. Careful surveys were made, and the water was found to be four inches above the marks in the fixed rocks and on the marble slab, but exactly thirty-one inches from the plug that had been driven into the buttonwood tree forty-eight years ago. The question for the jury to decide was whether the upper mill and rocks had sunk four inches, or whether the base of the buttonwood tree had been lifted that much. Notwithstanding ingenious arguments to show that trees only expanded in size and sent out new growths from the extremities of branches, the jury, composed of farmers or those bred in the country, decided that the buttonwood tree had been elongated, by giving a verdict for the plaintiff for $150. Counsel for the defence will file reasons for a new trial.

Propagation of Tubercle by Milk.

At the last meeting of the French Association for the Advancement for Science, M. Chauveau gave to the section what he termed a demonstration of the transmission of tuberculosis by the digestive organs. He observed that his numerous observations enabled him to state that if the healthy young of animals susceptible of tuberculosis were fed with food with which the matter of tubercle was mixed, they would all exhibit tuberculosis in various organs. In anticipation of this meeting, he had purchased some healthy calves; and, having had them fed as described, on slaughtering them the sixtieth day after the first ingestion, the lymphatic system was found extensively tuberculized, while caseous deposits existed in the lungs. This thesis he demonstrates most conclusively, and he is supported in his inferences by an apparently wholly independent series of experiments carried on by Dr. Klebs, in Germany, which he has recorded in one of the *Archiv fur Experim. Pathologie* (*Heft II*, 1873).

Dr. Klebs asserts that the milk of tubercular cows brings on tuberculosis in various animals. The affection generally commences with intestinal catarrh, followed by tuberculization of the mesenteric ganglia, the liver, and spleen, and ending in extensive miliary tuberculosis of the thoracic organs. Infection by means of the milk may be without result in vigorous organisms; and the author has even seen full formed tubercles resorb and disappear through cicatrization. It is likely, adds Dr. Klebs, that the tubercular virus is contained in varying proportions in the milk of cows which are more or less diseased, and the scrofulosis may occur, in children born without tubercle, through the milk of an unhealthy mother or wet nurse. In conclusion, the author expresses the view that the virus is contained in the serum of milk, in a dissolved state, and that it is not destroyed by boiling, which is ordinarily insufficient.

If these facts are not overstated, and they do not seem to be so, what a dangerous article must be that which is measured out in thousands of gallons daily, in all large cities, the product of phthisical cows, fed on distillery slops, and choked with foul odors! The milk of one tuberculous cow will contaminate that of the whole dairy when mixed in the cans.

The propagation of typhoid fever by milk has been only too clearly shown in London this year; and now have we not to lay to the charge of the same fluid the maintenance of a part of the terrible prevalence of phthisis among us?—*Medical and Surgical Reporter.*

LAUGH AND BE HEALTHY.—The physiological benefit of laughter is explained by Dr. E. Hecker in the *Archiv fur Psychiatrie:* The comic-like tickling causes a reflex action of the sympathetic nerve, by which the caliber of the vascular portions of the system is diminished, and their nervous power increased. The average pressure of the cerebral vessels on the brain substance is thus decreased, and this is compensated for by the forced expiration of laughter, and the larger amount of blood thus called to the lungs. We always feel good when we laugh, but until now we never knew the scientific reason why.

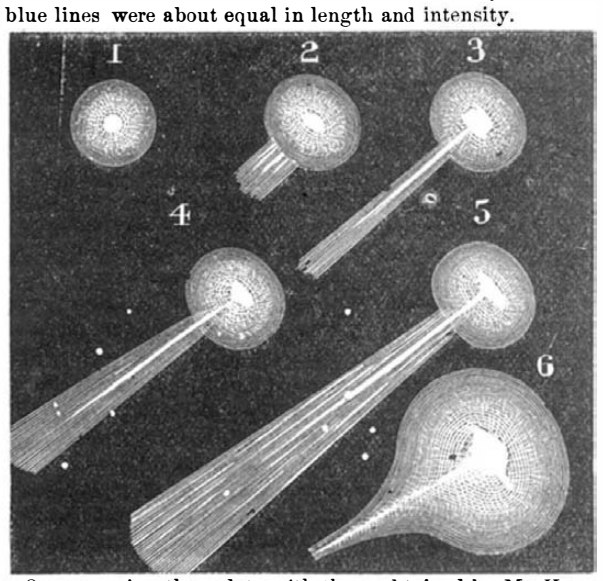
PROSPER HENRY'S COMET.

Comet IV of 1874, discovered on the 23d of August by M. Prosper Henry, at the Observatory of Paris, presents some remarkable peculiarities which distinguish it from all other and similar telescopic bodies. Its rapid changes of form, sudden elongation of tail, and its brilliancy, which became so great as to render it visible to the naked eye for some time previous to its passage to its perihelion, are considered to be phenomena which may throw light upon our hitherto indefinite knowledge regarding the constitution of comets.

On the day of its discovery, the body appeared as indicated in Fig. 1 in the accompanying illustration, the telescope showing a spherical nebulous mass, strongly condensed at the center, and exhibiting no traces of a tail. Its apparent diameter was about 4′, and it resembled a star of the 7th magnitude. There was little change in the aspect of the comet until August 26, when, as represented in Fig. 2, a tail began to appear, and the head assumed a slightly elliptical form, its diameter increasing to 6′. Three days later the tail, extending in a direction opposite to that of the sun, attained a length of 20′, and formed with the meridian, passing through the nucleus, an angle of 41°. Fig. 3. On September 2 (Fig. 4) the tail had grown to 2° in length and continued elongating. The nucleus remained nearly constant in size, although its brilliancy augmented until, on September 10 (Fig. 5), it became comparable to a star of the 4th magnitude.

The head of the comet, examined under a magnifying power of 200, times, appeared composed of three envelopes and a nucleus, the latter being situated near the summit. From the surrounding brilliancy emerged a luminous and very narrow thread, in which the tail appeared to originate.

From the observations of MM. André and Rayet, of the Observatory of Paris, and those of Mr. Plummer, at the Durham Observatory, the spectrum of the comet is found to be composed of three brilliant and very distinct bands. The first is in the yellow portion almost between D and E; the second, in the green, nearly coincides with line *b*; the third is in the blue beyond F. There was no trace of a continuous spectrum in the intervals between these lines. The green band was much the most luminous, while the yellow and blue lines were about equal in length and intensity.



On comparing these data with those obtained by Mr. Huggins from Comet I of 1868 (Wennecke's), it is concluded by Mr. Plummer that the spectra of both bodies are identical, and that the light of M. Henry's comet must be attributed to incandescent carbon, and hence the star must be self-luminous. M. Henry, in commenting upon this conclusion in *La Nature*, from which journal we extract our engraving, says that it does not accord with the fact of the variation of brilliancy of comets, which increases in luminosity as the latter approach the sun. It is also difficult to conceive that a body, of a mass so feeble as that generally attributed to comets, could retain for a long time a temperature so high as that required for the volatilization of carbon. It is, perhaps, more reasonable to suppose that the comet, illuminated by the sun, is a cold gaseous body, into the constitution of which carbon enters in the form, for example, of carbonic acid or oxide. This gaseous compound can evidently reflect only those rays which it is able to intercept, and such rays as are intercepted give only a few lines of the spectrum, among which are found those of carbon.

The polariscope, M. Henry believes, might furnish some valuable information on this point, and, used in connection with the spectroscope, he considers, must solve positively the question as to whether comets are or are not self-luminous.

A POISONOUS ANILIN COLOR.—The dye stuff called rosanilin which gives a beautiful carmine color, is, as we have stated an arseniferous production allied to arseniate of lime, and is soluble in lactic acid. It is used in lithography and for painting wooden vessels, etc. As it is very poisonous, it should never be employed in confectionery, and bright red sugar sticks should not be given to children.

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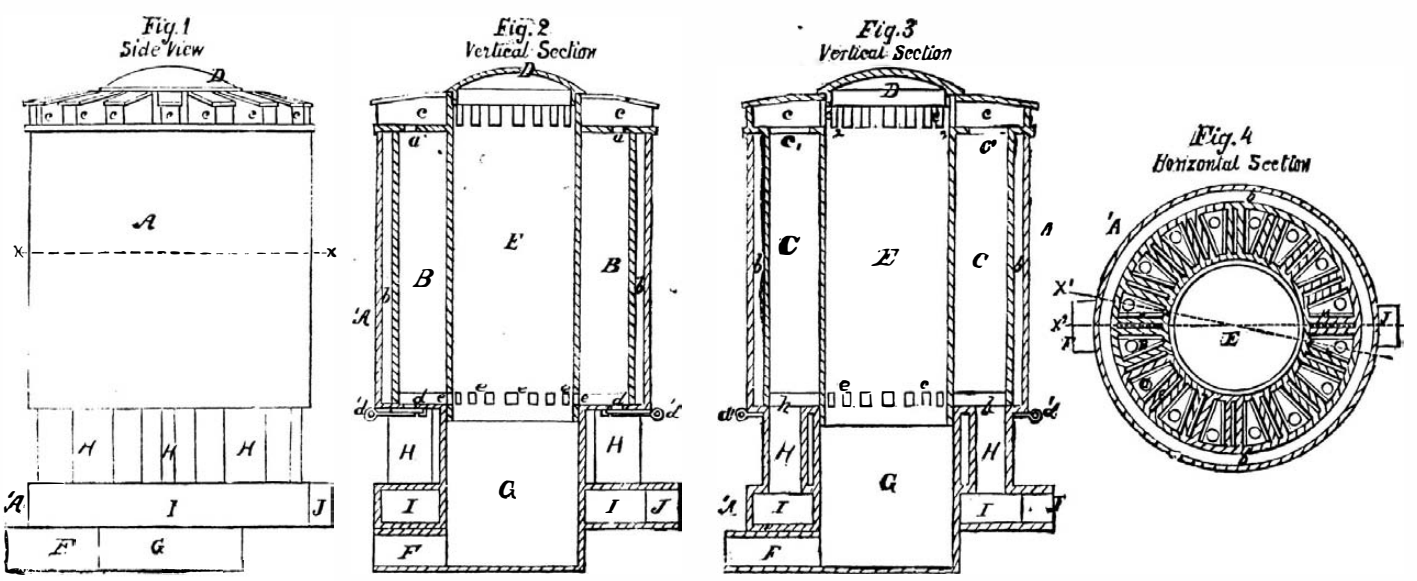
THE WILSON PROCESS FOR MAKING WROUGHT IRON DIRECT FROM THE ORE.

BY EDWARD M GRANT, C.E.

The repeated attempts to manufacture wrought iron direct from the ore are so well known that it is useless to recount the history of past inventions, and, therefore, I will proceed directly to a description of the process which I have investigated.

This furnace was invented and patented by Mr. Joel Wilson, of Dover, N. J., who has spent his whole life in the iron business, in England and America, and has been working on this process for nearly twenty years. His last patent was taken out in July, 1872; and his furnace has been in operation a portion of the time during the last twelve months. The stoppages have been caused by changes made at various times in the puddling furnaces, to adapt them to this process; several hundred tuns of iron have been made by this method during that time and sold in the New York market.

I first heard of this invention in August, 1872, and in December I came north for the purpose of making a thorough investigation of its merits. I brought several tuns of hematite ore from Alabama, for the purpose of testing the working of our native ores by this process. I became so much interested in the matter that I remained in the vicinity of the works until September, 1873, when they were closed in consequence of the panic. During this time I weighed nearly all the ore and coal used in the furnace, and kept complete records of the yield in muck bar from each retort, as well as the amount of coal used in puddling, time of heats, etc. I also preserved samples of muck bar from the various charges of ores, to test the uniformity in quality of the iron produced.



WROUGHT IRON DIRECT FROM THE ORE.—THE WILSON IRON FURNACE.

The accompanying diagrams will assist an explanation of the apparatus. The ore is crushed to the size of small shot, and mixed with the proper percentage of powdered coal, and then charged in the retorts, B, through the apertures, *a a*. These retorts are built of fire brick or tile, and dovetailed together in such a manner as to hold them firmly in position. They contain from 1,300 to 2,000 lbs. of ore, according to the comparative weight and bulk of the mineral. The heat employed is produced from the gases escaping from two or more puddling furnaces, which are conducted from said furnaces through the flues, F, into a collecting chamber, G, whence the gases ascend to the level of the base of the retorts at *d d*. Here part of the heat passes under the retorts through the small flues, *h h*, into the annular space, *b b*, thence up to the top of the furnace, where they are conducted through the conduits, *c c c*, into the intermediate flues, C′ C′ C′, and thence downward. The major part of the gases rises up through the central chamber, E, to the cap, D, thence through the conduits, *c c c*, and down through the flues, C C, uniting therein with the portion of the gases that went up the annular space, *b b*, thence down through the stand flues, H H, into the circular collecting flue, I I, which conducts the escape heat to the stack.

In this way the gases pass entirely around the retorts, heating them from the outside, while the ore is completely protected from the action of the puddling furnace gases.

After the ore in the retorts has been reduced by the action of the carbon mixed with it, and thereby freed from its oxygen, the metallic iron, in the shape of red hot particles (which flow freely, like fine gravel), is taken out at the bottom of the retorts through the apertures, *d d* (covered by the slides, *d′ d′*), and received into an airtight vessel, of my own design (thus protecting the ore from oxidation from the atmosphere), and is there transferred to a hopper, opening into the puddling furnace, whence it is charged upon the hearth beneath, without losing the heat absorbed in the reducing furnace.

This reducing furnace contains sixteen of these retorts, twelve feet high, arranged in a circle about the central chamber, E; the tiles forming the retorts are two inches thick and twelve inches in hight; all parts of the furnace exposed to the action of the products of combustion are constructed of fire brick or cast iron lined with fire clay. The central chamber, E, is seven feet in diameter, and this size of the passage prevents any cutting away of the brickwork by the flame, and also produces an even distribution of the gases through the intermediate flue system, C C C. The heat which escapes from the flue, J, looking to the stack, is sufficient to raise steam for blast and rolling machinery. One of these reducing furnaces will supply three puddling furnaces with reduced ore, so as to keep them in constant operation, and the escape gases from two of these furnaces will furnish all the heat required to deoxidize the ore.

The construction of the puddling furnaces is based upon the same general principle as that adopted in ordinary bar mills; they are lengthened out, however, so as to form three bottoms, about the ordinary size; the first, next to the flue, is inclined, and upon this hearth the ore is charged; it is thoroughly heated up here, and is then moved forward upon the second hearth, by a tool designed for the purpose, where it is heated sufficiently to melt the slag produced by the fusion of the impurities of the ore; from there it is moved to the third bottom and balled up. The operation is continuous, as a second charge is placed upon the first bottom as soon as the first one is moved to the second hearth. The puddling involves less muscular exertion than that required for working pig iron, and only requires one laborer in addition to the usual puddler and helper employed in the ordinary furnace; and the yield from the puddling furnace is fully equal to the production of similar furnaces in using pig metal.

The operations of hammering or squeezing, rolling, etc., are, of course, the same as in the ordinary working of pig iron blooms. A tun of finished iron can be made with two tuns of coal, including that used for reducing purposes. The cost of these reducing furnaces is a small item, and they can be erected in any rolling mill, and the puddling furnaces modified as described, and thus render the mill owners independent of the blast furnaces.

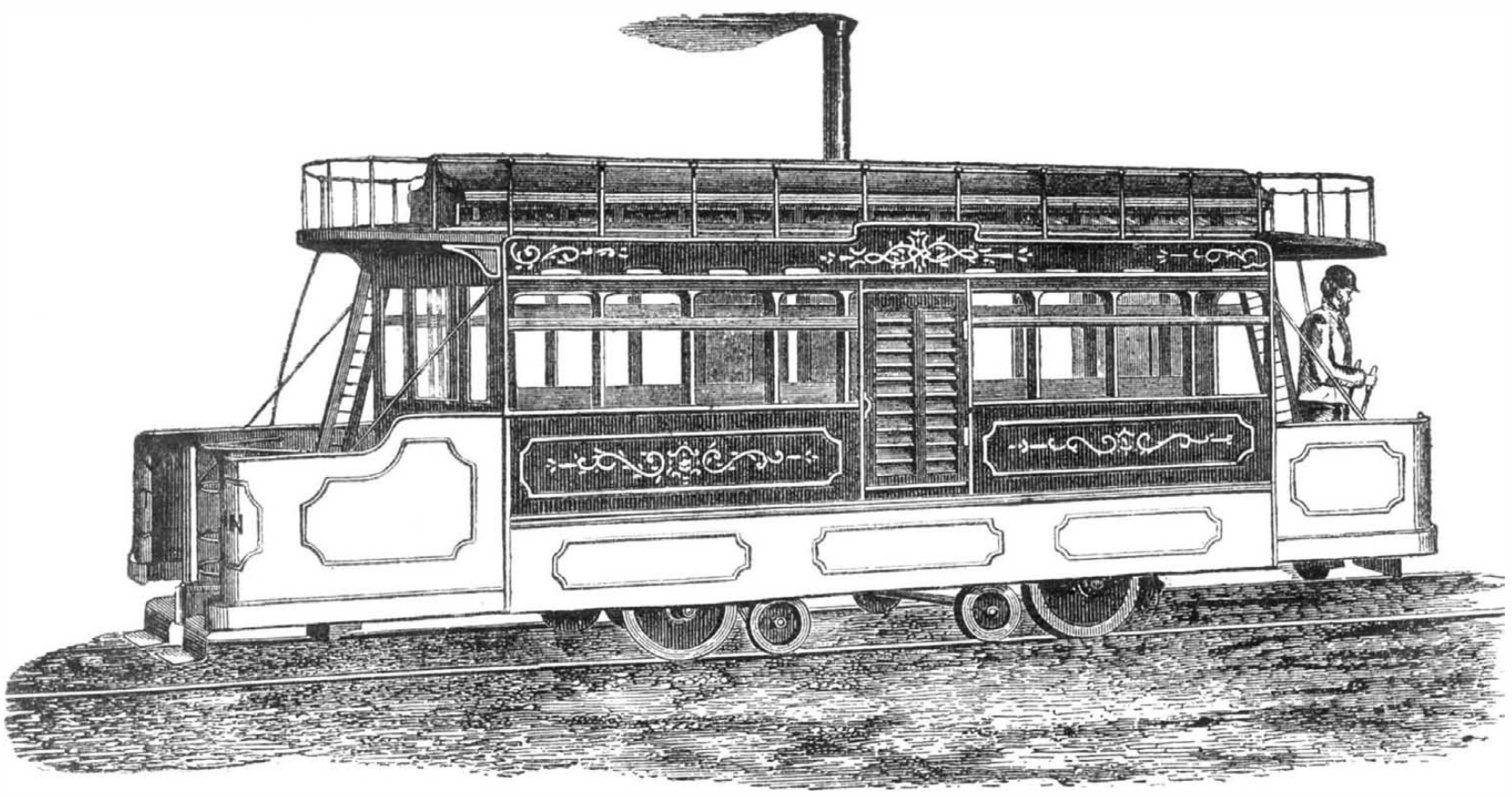
The yield in muck bar from the ore is about the same in amount as that obtained at the blast furnace in the shape of pig iron. The Alabama ore assayed 54 per cent, and I obtained 47 per cent muck bar. Seven tuns of ore sent me from Georgia assayed about 50 per cent (being surface ore) and yielded 45 per cent. Spanish ore from Bilboa, assaying 48½ per cent, yielded 45 per cent, and many ores from New Jersey and adjacent States yielded to within two to five per cent of the assay. Magnetic and hematite ores were worked with equal facility, and they were mixed together in various proportions, fully demonstrating that mixtures of ores could be worked so as to produce any kind or quality of iron desired. The muck bar showed a uniform fracture both in color and texture, and there is no question about this process producing a quality of iron equal, if not superior, to any produced from the same ores by the old process. The degree of heat employed in the reducing furnace is not sufficient to produce any visible effect upon the bricks, and, therefore, they will endure a long period of service. The furnace is surrounded by a casing of tank iron, with a fire brick lining between the iron and the annular space, *b b*.

Ores containing an excess of impurities may be fluxed in the puddling furnace with perfect facility.

During my investigations, every facility was afforded me by the proprietors of the works; and for a good portion of the time, the operations were practically under my own direction, the inventor following my suggestions so that I might have every point tested in my own way, and to any extent deemed necessary. My conclusions were so favorable that we should have had our works in the South, upon this plan, well under way by this time, but for the unexpected stringency in the financial world, which has, of course, postponed all new enterprises.—*Engineering and Mining Journal.*

A NEW STEAM OMNIBUS AND STREET CAR.

Our engraving illustrates a new style of steam passenger cars, for street railways, the invention of Mr. Grantham, of London, where the improvement was lately tried. Two small boilers are used, one on each side, fired from the ex-



NEW STEAM OMNIBUS AND STREET CAR.

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terior of the car. This novel vehicle has a double set of wheels, one set with flanges, intended for use when the machine runs on the street railway track, the other set being employed when running on common roads. Most railway cars and locomotives are useless when at the end of the track; but not so with this device. It can then steam off, independent of the track, through streets or roads, as far as may be desired. The axles of the flanged wheels are supplied with cranks and rods, and with a worm wheel and lever, under the control of the driver, who may, at any moment, raise up the flanged wheels, so that the vehicle will rest on the plain wheels, for running on common roads. The axles of the plain wheels have a screw steering device connected with them, so that the vehicle may be guided in any direction. The car is provided with seats on the top, and, as shown, has a capacity for some forty or fifty seats. But the end platforms, it appears to us, are too long. Taken as a whole, however, this device presents some good ideas, and is creditable to the inventor.

Correspondence.

Pisciculture in its Sanitary and Commercial Aspects.

To the Editor of the Scientific American:

Your reply, in your 18th of October number, to S. W. G.'s inquiry for information as to the best materials to be employed and mode of employing them in the construction of a dam for a fish pond, was read by me with very great interest, in connection with the general subject of pisciculture and utilization, especially in this form of enterprise, of small sheets of water in proximity to large centers of population.

I believe, most firmly, that a larger and cheaper supply of fish than that at present existing would be readily appreciated by every class, and prove most conducive to the more general promotion of health. Meat is good for food, but a vast quantity of meat, seemingly healthy to the utmost microscopic and scientific investigation, is really more or less the reverse, owing to the kind of food used in forcing the process of fattening, and also the habit, in order to accelerate it, of keeping the animal in a state of compulsory inactivity. We are indebted for the comparative immunity we happily enjoy from the natural, morbid consequences of consuming this, as well as many other kinds of really deleterious articles of food, to the benevolence of the *vis medicatrix naturæ*, or *vis vitæ*, to use the language of medicine. But when a man turns the age of 45 or 50 years and his vital power begins to weaken in its resistance to what is injurious, then does he begin (and continue, by an inevitable law of physical life, in accelerated ratio as his years increase) to suffer in one way or many ways, in one organ or many organs, as may be determined by congenital idiosyncrasy or acquired habit. The evil becomes deeper, more irradicable, and therefore more dangerous, by the slowness with which it grows. The remoteness of the effect from the cause throws suspicion into fatal sleep until awakened by the magnitude and seriousness of disease; the physician is called on and in vain invoked to exorcise by a drug the seven spirits which, insinuating themselves into the very citadel of life, refuse to leave until accompanied by that life which they expressly came to take away. But I must not allow myself to be carried away into inordinate length by my subject. I shall not, therefore, anticipate the answer that possibly might be urged—for assumption grows in extravagance with the extent of ignorance—derived from the easily accessible quantity of salt fish. Neither shall I touch on the admitted, because admitted, healthfulness of change of food. My object is simply to avail myself of the most potent of all arguments why our attention ought to be more generally directed to the utilization of our lakes for the propagation of fish—the commercial argument. I have been very much astonished by the reports in American papers (I am a Canadian, residing in Canada) of the wonderful financial results of a few private enterprises of this kind, notably on, I think, Long Island. One gentleman digs a pond, and builds a hatching house, at a total expenditure of $1,500, and after some two years begins to reap a clear profit of $3,000 a year, with a stock of fish on hand (I refer here exclusively to trout) valued at more than treble this sum. The reports of others are simply confirmatory of this. It is a crop that sows itself, that needs no plowing, harrowing, drilling or cultivating of the soil. The crop itself does all this. It is therefore nearly all profit. You are already beginning, with that intelligence and foresight now indigenous with you, practically to appreciate the enormous pecuniary as well as sanitary value of this industry: why should it more especially urge itself on me? Because I live within a few miles of a country—the northern bank of the river Ottawa—abounding in lakes, large and small, some teeming with the finest trout, but nobody cares to catch them; open to all, or rights may be purchased for a comparative trifle by any person, waiting for some enterprising and intelligent person to come and occupy and enrich himself as well as others. The land is, for the most part, rocky, mountainous, wild, but healthy in the extreme and picturesque. In eager exploration for minerals, the mind cannot, it would seem, appreciate the value of the living minerals which in vain, by their glitter, attract the eye and fearlessly invite attention to their numbers and their beauty.

You have an equal share with ourselves already in our salt water fisheries. It must be because you are ignorant of the extent, perhaps the existence, of our fresh water fish that I suppose you are not already catching and exporting them. You have invaded our forests and are rapidly cutting them down and carrying them off, and profiting by the operation. I think I may safely promise your appearance with rod and bait a very warm welcome, and a very profitable result. But I must desist. I do not know if you will consider this a suitable subject for your paper; if so, I shall gladly hail its appearance in the interest of my aim, the extension of a valuable industry and the promotion of our physical well being.

These remarks embody the views of our very intelligent Deputy Minister of Fisheries, enunciated some time ago in a conversation with me. The subject is, with him, one of scientific as well as practical interest. CANADIAN.

Magnetism and the Nodular Form of Iron.

To the Editor of the Scientific American:

Those much acquainted with magnetism are familiar with the magnetic curves described by iron filings, when shaken about a bar magnet. If we lay on a bar magnet a pane of glass, and shake upon the glass some fine iron filings, and gently strike the glass, the filings will distribute themselves after a certain uniform manner in obedience to a force operating them from the magnet. If our magnet be a square bar, and we turn it one quarter of the way over, and again try the experiment, a similar distribution of the filings will ensue. What must we conclude from this? Obviously that the force of the magnet does not exert itself simply in the plane in which the filings lie upon the glass, but in an infinite series of planes, extending in every direction about it. If the magnetism were sufficiently strong to counteract or annul the force of gravitation, or the filings were free to move among themselves, they would arrange themselves about the poles of the magnet in an elongated globular form. Furthermore: If the atoms of iron of which the bar itself is composed, and which are magnetized, could overcome the force of cohesion, or were alone acted upon by the force of magnetism, they would arrange themselves in accordance with the law governing the magnetic curve. Hence, in all magnets, the atoms of which they are composed are under a strain, which is in proportion to the degree of magnetism by which they are influenced.

I deduce from the foregoing the following corollary: The best shape for a magnet is that in which the circumscribed boundary of any part of its surface will exactly coincide with the exterior magnetic curve, considering the curve to extend in every direction from the center of either pole. I also find in the above theory an explanation of the fact that iron which has been deposited from solution (as in the clay basins of Missouri) has assumed a globular shape, and is almost universally found in nodules. The atoms of iron have been deposited in obedience to the magnetic force; and being in solution and free to move, the atoms, in aggregating, have arranged themselves on the magnetic curves. While this was going forward, the nodules were probably in pairs. Subsequently, violent action has rended them asunder, causes have operated to demagnetize them, and oxidation and attrition have modified their primary form.

Louisville, Ill. C. H. MURRAY.

Coal Tar Products.

To the Editor of the Scientific American:

Allow me to add, to your list of the products of coal tar, rhigoline, which is now used in the artificial manufacture of ice. There is also a beautiful black varnish for iron, which dries quickly and produces a gloss almost equal to Japan; this is made by dissolving the pitchy residuum of coal tar in the heavy oil that distils from the same, being the only liquid which will dissolve it. This varnish is known to the trade as paraffin varnish, but this is a misnomer, as that article, although a product of coal tar, does not enter into its composition.

A few years ago I was connected with the coal tar pitch interest in such a manner as to lead to a series of experiments. In the years 1861 and 1862, I was engaged in the manufacture of a cheap quality of sealing wax for capping fruit cans. Cincinnati at that time enjoyed a monopoly in that trade, supplying dealers at all points. In the years named the price of rosin advanced (owing to the war) from $1.80 to $40.00 per barrel, and was difficult to obtain at that price: which caused the manufacturers here to look for a substitute, which was found in coal tar pitch. So well did it answer the purpose that at least fifty tuns were cast into suitable shape and sold for sealing wax, the only objection to it being the odor.

The beautiful gloss of this wax, together with its strength and the facility with which it could be cast into molds, led me to make some experiments as to its value as a material for decoration, picture frames, statuary, etc. This resulted in my securing a patent on the 5th of August, 1865, covering its use for the manufacture of a variety of useful articles. From that time until the present, I have endeavored to develope my invention, being convinced that it will be as useful as vulcanized rubber in time. I send you a blacking box, cast of the material, which please accept as a curiosity, being another link in the long chain of useful products of the unsightly and formerly despised article, coal tar.

Cincinnati, O. J. T. PEET.

THE CURABILITY OF CONSUMPTION.—This is the attractive title of a very excellent article in the *Deutsches Archiv fur Klinische Medicin*, June, 1873, by Dr. Massini. He shows, first, that true tubercular consumption is curable, as post mortems of persons dying with other diseases prove. That it is communicable he also attempts to prove, and hence he disapproves of consumptives marrying. The means of prevention are general and special. His enumeration of them includes nothing novel; but with most of the later German authorities, he is strongly in favor of elevated health resorts—pure mountain air.

ALUMINA, FROM THE CLAY TO THE SAPPHIRE.

READ BEFORE THE POLYTECHNIC CLUB OF THE AMERICAN INSTITUTE, ON DECEMBER 18, 1873, BY DR. L. FEUCHTWANGER.—CONCLUSION.

It has been stated that alumina is the oxide of the metal aluminum. We will now proceed to describe the process of obtaining this peculiar metal, and its qualities and applications.

It is an earthy metal, like cerium, zirconium, glucinum, erbium, and yttrium, and was first prepared by Wöhler in 1828; it is one of the most important metals on account of its usefulness in the arts. Its extraction from its mineral compounds, however, is not very easy, or it would ere this have been the great rival of the precious metals; in fact it possesses some qualities superior to them. Several methods have been proposed for its extraction, all of which depend upon the use of metallic sodium. Common clay, cryolite, and other aluminous minerals may be employed, but the mineral called bauxite, from France, containing about 60 per cent alumina and 40 per cent silica, is now principally employed by the large manufacturers in Europe. The process is as follows: Pulverized bauxite is mixed with powdered soda ash, and fused at considerable heat, during which process the aluminate of soda is formed, and carbonic acid escapes; the fused mass is dissolved in boiling water, and the clear solution evaporated; then the redissolved aluminate is neutralized with hydrochloric acid, whereby a chloride of sodium is obtained, and the alumina is converted into a hydrate of alumina, which, being mixed with charcoal and common salt, is formed into balls and heated in earthen cylinders, dry chlorine gas being passed through the heated mass. Chloride of aluminum and chloride of sodium are thus produced, going over into the retort, the carbon abstracting the oxygen from the alumina. Metallic sodium is now mixed with the two chlorides, and heated in a reverberatory furnace. Metallic aluminum is then found at the bottom of the melted chloride of sodium; this is now separated from the fused mass, and may be remelted, cast in bars, and then rolled out into sheets and wire. The chloride of aluminum is as yet the only vehicle suitable for the extraction of the metal; it may be easily produced by fusing the ammonio alum with charcoal and then passing a stream of chlorine gas through the mass; the chloride goes over in the form of vapor which condenses in a receiver as a solid crystaline mass. The metallic aluminum is now largely manufactured in France and England; the business has been attempted in the United States (from cryolite, by Monier and Parmele), but has not been carried to any extent.

Aluminum possesses the following remarkable properties: It is of white color, resembling silver, and is very sonorous, more so than any other metal; it is the lightest metal, having a specific gravity of 2·5 (while silver has a specific gravity of 10·53); this property renders aluminum very valuable in the arts, such as for making small weights used in chemical analysis, for dentists in the manufacture of plates for artificial teeth, and many ornamental purposes, particularly as it resists so well the action of a moist atmosphere. It even resists boiling nitric acid; this property puts it on equality with gold and platinum; but hydrochloric acid attacks it. It is, however, not blackened by hydrosulphuric acid. It is infusible in cast iron heat by exclusion of air, but burns in the same with brilliancy, and in oxygen gas the combustion is so fierce that the eye can hardly bear to look on it; it is then formed into the earth alumina. It dissolves readily in dilute caustic alkali, such as ammonia, and in dilute sulphuric acid; it is not attacked by cold sulphuric or nitric acid.

Aluminum bronze is an alloy of 1 part aluminum and 9 parts metallic copper. It has the color of gold, but becomes dull after a while, and it is as strong as iron; neither mercury nor lead, both of which generally attack other metals, has any effect on aluminum.

ALUMINA.

It has been remarked that alumina is found in Nature almost pure in the sapphire, corundum, emery, spinelle, topaz, diaspore, in the vast deposits of clay, and in all silicated minerals. In order to obtain the same pure and in a hydrate, the following process is adopted: Commercial alum, free from iron, is precipitated by a concentrated solution of carbonate of soda in excess; the precipitate is redissolved in hydrochloric acid, and again precipitated by ammonia; this precipitate is then calcined, and the result is a pure hydrate of alumina. A more simple method is by igniting the pure ammonio-alum, also by the decomposition of a solution of alum and chloride of barium. The pure alumina is colorless and tasteless, and wholly insoluble in water. If a little alum is dissolved in warm water, and some ammonia is added to the solution; the latter combines with the sulphuric acid, while the alumina unites with water so as to form a semi-transparent gelatinous mass, which is the hydrate of alumina; this has a great affinity for many coloring matters, forming the well known lake pigments.

SULPHATE OF ALUMINA

is also called porous alum, concentrated alum or alum cake. This very important substance, of extensive application in the arts, is produced either from common pipe clay, kaolin, shale, or cryolite. From clay, it is prepared by calcining the same and treating it with half its weight of sulphuric acid, until it becomes a stiff paste, which is then exposed to the air for several weeks; sulphate of alumina is produced, which is washed out with water so as to leave the undissolved silica behind; the clear solution is evaporated to a sirupy consistence and allowed to cool; it then solidifies into a white mass, and this is the cake or concentrated alum, which is extremely soluble. The alum shale is much employed for this pur-

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pose in Europe by roasting it in heaps and setting fire in several places under them; the iron pyrites (a usual companion of all shales) produces a decomposition, and sulphurous acid is evolved. On exposure to the atmosphere, as above stated, the sulphate of alumina is obtained.

In Pennsylvania, the cryolite from Greenland is altogether used for the manufacture of the alum cake, by the following simple method: The cryolite is mixed with chalk and calcined, and a double fluoride of aluminum and sodium is produced; while the fluoride of calcium, first formed, gives off its oxygen to the sodium and aluminum, converting them into soda and alumina. The soda is now crystalized out of a solution with the assistance of carbonic acid gas which is passed into it; and after setting the same aside, the soda as the carbonate crystalizes out of it, leaving the pure alumina in the mother liquor to be treated with sulphuric acid.

Sulphate of alumina has a sour taste, but also a sweet and astringent aftertaste; it is soluble in twice its weight of water. It is a powerful antiseptic and arrests animal putrifaction, and can be used for preserving bodies. Porous alum or sulphate of alumina is very extensively used by calico printers and papermakers, and is, in many instances, preferred to alum.

ALUM.

This, the chief compound of aluminum, employed so extensively in the arts, is obtained from the last mentioned substance, the sulphate of alumina. The solution is mixed with sulphate of potash, when, on evaporation, beautiful octahedral crystals are obtained. Sulphate of ammonia, as obtained from gas liquor, is now generally substituted for the potash; and instead of a potash alum, ammonia alum is now altogether put in market, although many manufacturers believe they obtain the old fashioned potash alum; but the ammonia alum answers as well in dyeing, calico printing, papermaking, etc., and in the manufacture of colors. In England, the chloride of potassium was formerly used in the manufacture of alum, this being a waste product from the soapboiler and the saltpeter refiner.

Ammonia alum is found native in Bohemia as a mineral, called tschermigite, which occurs in fiberous crystals, but not in such sufficient quantities to be of practical use. There are, however, many minerals from which alum can be extracted, and the localities may be seen all over the world: in Germany, particularly in the neighborhood of Halle in Prussia, on the island of Riga in the Baltic, in Bohemia, in Hungary, in England (where the deposits are most extensive), and in the United States.

The following sources of alum are mentioned, as they yield the mineral used for the production of alum and alum cake, independently of the pure clays or kaolins brought into market and used most extensively for the manufacture of porcelain, pottery, and Rockingham ware:

Alum earth, a mineral deposit in the brown coal formation.

The alum slate is a dull earthy black slaty mineral, of specific gravity 2·4; it contains some bituminous matter and fossil remains, and is found in England, the Netherlands, and Prussia.

The alum stone, called alunite, of obtuse rhombic form and white color. It has a vitreous and pearly luster, yielding: alumina 14 per cent, sulphuric acid 25 per cent, silica 24 per cent, potash 4 per cent, water 2 per cent; total, 100. In 1866, I found it between the gneiss and granite, in an efflorescent state, at First avenue and 51st street, in this city. The mineral is found in lava and trachytic rocks at Talfa near Rome, in Hungary, and in Auvergne, France. This material was used 1,000 years ago for producing the alum, and is called the Roman alum.

The aluminite, found abundantly in Prussia at Halle, and at Epernay in France, is also called websterite, and contains alumina 30 per cent, sulphuric acid 24 per cent, water 46 per cent. It is white and opaque; it adheres to the tongue, and has a specific gravity of 2·0. It is rather abundant in the localities named.

The many applications of alum in the arts are due to the alumina having great affinity for many coloring and other vegetable matters, for gelatin, etc.; and in the preparation of lakes, it forms an insoluble precipitate of alumina with vegetable colors. It is also used in preparing white leather by its action on gelatin, for clarifying water, as an addition to paste used by bookbinders, for preventing the depredations of insects, in fireproof safes as a filling, etc. Alum has been described by authors as early as Pliny and Dioscorides. Boerhaave gives a very extensive description of it, and says:

Alum is a real fossil, procured either from a hard flaky stone, found deep in the ground, and so pregnant with sulphur and bitumen as easily to take fire or form a bituminous and combustible earth, which yields a noxious flame and a sulphurous stench. If exposed for a month in the open air, it crumbles into powder, and thus becomes disposed for the generation of alum, which before it was not. If dissolved in water, it may be precipitated by adding a fixed or volatile alkali; and it then produces a new salt, which is the alkali and the fossil matter together. In England, Italy, and Flanders, alum is principally produced." He also says "that alum has a sharp, rough, styptic taste. Its crystals are octagonal, four of the sides being hexagonal, and the other four triangular, surfaces. In Italy (at Civita Vecchia and at Solfatara, near Patella), the alum is manufactured from the natural substance in summer time.

Let me add a few words more about alum and its physical and medicinal properties. Alum is a white, slightly efflorescent salt, it crystalizes easily in octahedrons, but may be made to crystalize in cubes, if an excess of ammonia is added to the solution, which must be carefully evaporated; it dissolves in warm water, say in three fourths of its weight of boiling water. It is insoluble in alcohol, and has a specific gravity of 1·71; it reddens litmus, and changes the tints of the blue petals of plants to green; it assumes an aqueous fusion when heated to 212° Fah. Exposed to red heat, it gives off oxygen with sulphurous acid. It forms pyrophorus when calcined with fine charcoal, and then spontaneously forms an inflammable substance. There are several varieties known in commerce, among others, the Roche alum, which originally came from Rocca in Syria, of a pale rose color; and the Roman alum, which has always been considered as the purest. Five thousand tuns are still annually manufactured.

Alum is incompatible with the alkalies and their carbonates, lime and lime water, magnesia and its carbonate, tartrate of potash, and acetate of lead. It is an astringent and antispasmodic; in large doses, it is purgative and emetic. In cases of hœmorrhage, sweats, diabetes, chronic dysentery and diarrhœa, it is used as an astringent. It is used as a purgative in the painter's and nervous colics. Alum is also sometimes used for the adulteration of bread, with a view to increase the whiteness, but in very small doses.

It may be stated, in conclusion, that a great many minerals, known by mineralogists as oxygen compounds, the unisilicates, hydro-silicates, and some bisilicates, contain the oxide of aluminum or alumina as one of the component parts. The family known as zeolites, such as laumonite, natrolite, analcite, mesolite, scolecite, thompsonite, gmelinite, phillipsite, harmotome, stilbite and many more of this class each contain from 20 to 30 per cent of alumina, pachnolite 25 per cent, and staurolite 50 per cent. Kyanite contains 64 per cent. Several mineral springs in the United States, in Virginia, contain the alum in solution from 20 to 70 per cent, and are used in medicine.

I may say that alumina exists in the most common as well as the most precious minerals. White clay or kaolin is found in many localities in the United States to a very large extent. I have visited many deposits in Vermont, near Brandon, in Massachusetts, in Pennsylvania, at Jacksonville, Ala., and in South Carolina. At Bath I saw large deposits of a fine quality, and 10,000 tuns are annually brought to this city for papermakers' use. At Aiken, S. C., large deposits are yet undeveloped. At Perth Amboy, various qualities have been dug out for the last 50 years from strata 20 feet thick. It is found in the coal, tertiary, metamorphic and older formations. Stourbridge clay, so indispensable for glass pots, is principally brought from England. Alum is a very important branch of commerce. England produces annually 10,000 tuns, and Germany 10,000: and in the United States about 5,000 tuns are manufactured.

Death of the Big Rhinoceros in the London Zoological Gardens.

The "Zoo" is in mourning for one of its hugest and oldest inhabitants. The great rhinoceros, which had been from its earliest days a conspicuous object in the elephant house, has at last succumbed to the scythe bearer, or whoever the rhinoceral typical representative of death may be. For twenty-four years the creature had lived in comfortable quarters, and withstood the rigors of an English climate; for twenty-four years it had, day after day, partaken of its plain meals of hay and similar food, and day after day for twenty-four years it had thrust its snout as far as possible between the massive bars of its den, and opened its capacious jaws to receive the gratuities of its admiring visitors, in the shape of buns and biscuits, oranges and apples, and other titbits. The rhinoceros is liable to sudden outbursts of violent temper, and the late lamented individual was no exception to this general failing of its race.

Several years ago, in a furious attack on the rails of its den, it broke its jaw, and was for some time in rather a dangerous condition. It, however, survived the accident and has safely passed through the vicissitudes of English weather, and it may be considered that twenty-four years is about the average length of life among this species of pachydermata. The hippopotamus has bred in the gardens, but no success has attended the attempts to breed the rhinoceros in captivity, their violent tempers rendering it dangerous for them to be temporarily housed together. The skeleton and skin of the deceased creature are to be preserved, and valuable preparations will no doubt be made.—*London News.*

Railway Receipts and Expenses.

The proportion of working expenses to receipts is often put forward as evidence of the cheapness or dearness with which a line is worked; while in fact it proves nothing at all, either one way or the other. Recently a statement of the proportion of expenses on the Denver & Rio Grande Railway has been widely published at home and abroad as evidence of the cheapness of working a narrow gage line, the percentage given in the case before us being 48·5 per cent in August, and 45·4 per cent in September last. The proportion of expenses depends equally on two things: 1. The cost of transportation, and, 2, the rates received. Evidently, if it costs me two cents per mile to carry passengers and I get three cents for it, my working expenses will be 66⅔ per cent; while if I receive 4 cents per mile these same working expenses will be but 50 per cent. On the Denver & Rio Grande, we understand, ten dollars is charged for carrying a passenger 76 miles, and at this rate working expenses of 45 per cent give nearly six cents per mile as the cost of doing the work. This is no argument against the road and its management, for the traffic is light, and heavy charges would be necessary to support a road of any gage. The Central Pacific, whose charges are not half so high, is worked for 40 per cent of its earnings, its rates being still higher than those of most American roads with equal traffic. The Panama Railroad is worked for about 44 per cent, we believe, and one might think it wonderfully economical; but its charge for carrying a passenger 47 miles is twenty-five dollars, so the cost would appear to be something like 23 cents per mile.—*Railway Gazette.*

The Hours of Labor.

E. W. says: "I regret that A. B. Mullett falls into the very common error of accepting eight hours' labor as costing but twenty per cent more than ten hours, instead of twenty-five per cent more. Let me quote the following letter, written by me in June, 1872: 'If a piece worker asks 20 per cent advance to equalize wages, when the time worker has his hours reduced from 8 to 10, it does not make them equal in pay, as the former will find on experiment. The manufacturer, too, will find that, so far as the day hands are concerned, his wages account will be increased 25 per cent. If I have two hands at work, making shirts: to one I pay $4 per day, for 10 hours, and he makes 4 shirts per hour, or 40 shirts per day, costing me, of course, 10 cents each for labor; the other hand works by the piece, at 10 cents each shirt, makes 40 per day, and gets, of course, $4 per day. So far, so good; but the day worker now wants to work but 8 hours for $4; and he will produce for me, at 4 shirts per hour, 32 shirts, costing me 12½ cents each; certainly 25 per cent more. The piece worker then asks for 20 per cent advance over original price of 10 cents, and gets thereby 12 cents each for his 32, and, consequently, earns but $3.84, so that he does not equalize wages.' If, under the 8 hour programme, I have to employ five people to work 40 hours, when four now accomplish that much, am I not paying 25 per cent more wages?

"It has been asserted that a mechanic can produce as much work in 8 hours as in 10. If he can do that for his employer, why cannot the piece worker do that for himself, and not ask 20 per cent more to equalize?"

A New Floral Ornament.

A writer in *Les Mondes* suggests a new idea for floral decoration, which, it seems, may be readily put in practice. An ordinary earthenware flower pot is filled with water, the hole in the bottom of course being closed, and allowed to stand until its porous sides are completely soaked. The water is then thrown out, and the pot is repeatedly dipped until it will absorb no more, and its outside becomes thoroughly wet. On the outer surface fine seed is thickly sprinkled and allowed to remain sticking thereto. The pot is then refilled with water, and set in the shade under a bell glass. In a short time the seeds will germinate and throw out shoots, so that, to prevent their falling from the sides of the pot, some thread or wires must be repeatedly wound around the exterior of the latter. Eventually the entire vessel will become a mass of living vegetation, which is nourished by the percolation of the water contained within through the porous sides.

A non-porous receptacle may also be used, but some thick cloth must be wound about its exterior and the seed sprinkled thereon. This cloth is kept continually moist by repeated applications of fresh water.

The Wear of Gold Coin.

It appears from experiments made in St. Petersburgh that, contrary to the opinion generally entertained, gold coin wears away faster than that of silver. Twenty pounds of gold half imperials, and as much of silver copecks—coins of about the same size—were put into new barrels, mounted like churns, which were kept turning for four hours continuously. It was then found, on weighing the coins, that the gold ones had lost sixty-four grammes—the silver ones only thirty-four; but as the number of gold pieces was twenty-eight per cent less than those of silver, the proportion is of course greater to that amount in favor of the latter. The silver also contained more alloy than the gold.

Nickel in Missouri.

A correspondent, "Nick," writes to point out a slip of the pen in our issue of December 13, 1872, wherein we stated that the nickel mines of Pennsylvania are the only ones in the United States.

"In your paper of November 30, 1872, you have an article on American nickel, wherein you mention the mine La Motte tract, Mo.;" you also mention elsewhere that the ore is found in Pennsylvania and Missouri. The nickel mines of Mine La Motte are now being very extensively worked at the present time, and the owners, the La Motte Lead company, have turned almost their entire attention to raising and reducing the nickel ore to regulus, which is being shipped in large quantities. Recently 7,000 lbs. of nickel ore were raised in one day; it assayed 35 per cent metal, and was worth $1 per pound at the mine. The work was done by six miners, $7,000 being dug out for a cost of less than $25.

An Excellent Pen.

Messrs. C. M. Fisher & Co., of No. 102 Fulton street, in this city, have devised a new form of gold pen, known as the Paragon, in which not only the form but also the characteristics of the quill are closely imitated. To those who have been accustomed to write with the latter, and have experienced the trouble of mending it, the gold pen, as made by the above firm, will, we think, prove to be a welcome addition to the writing table. We have used one almost constantly for the past month or two, and at the present time it is perfectly flexible, shows no sign of wear, and is one of the best pens we ever used. The makers adapt each pen to suit the hand; and hence, any peculiarity of holding can be allowed for, and the habits of the individual writer consulted.

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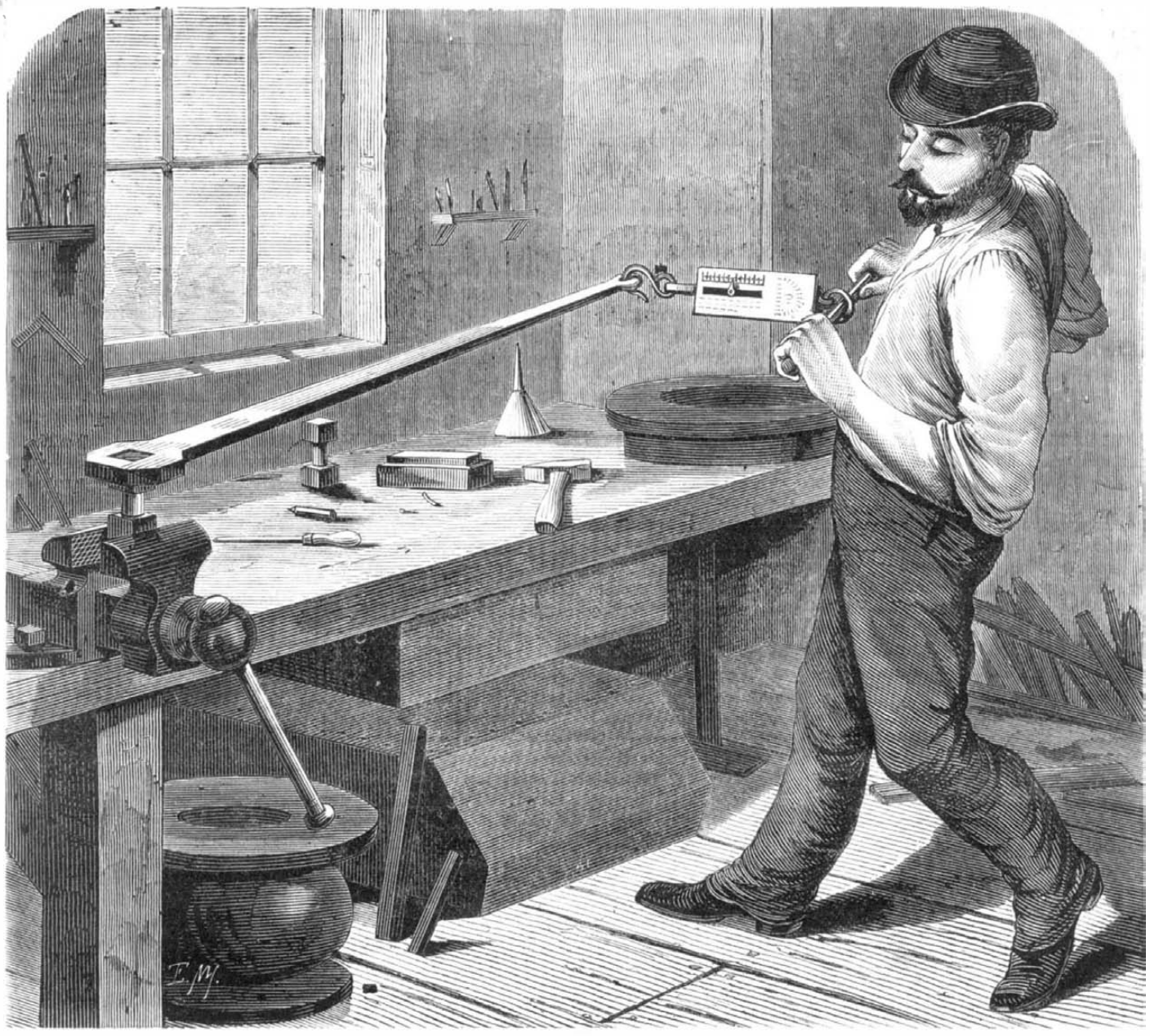
TESTING THE QUALITY OF IRON, STEEL, AND OTHER METALS, WITHOUT SPECIAL APPARATUS.

BY PROFESSOR THURSTON.

1. During the research which has occupied a considerable portion of the time of the writer recently, and to which reference has been made in the earlier numbers of the SCIENTIFIC AMERICAN, some very interesting facts have been observed; and much has been learned respecting the strength, stiffness, elasticity, ductility, and resilience of the metals used in engineering, which could only have been accurately obtained by means of apparatus capable of recording both the amount of distortion of the test piece and the coincident distorting force, at every instant during the experiment, up to the point of rupture.

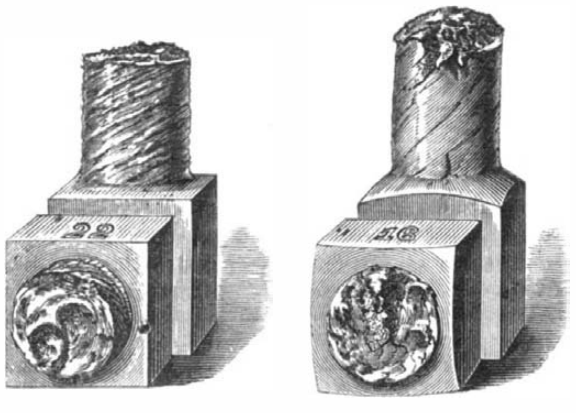
2. Among these developments, and not the least important, has been the fact that the quality of any given material can be determined with some approach to accuracy, by adopting the *method* here in use, but without necessarily going to the expense of purchasing the powerful machines in general use for determining tensile strength, or even paying the two or three hundred dollars which is charged at the shops of the Stevens Institute of Technology for the recording machine with which these tests were made. A strong long handled wrench, a good spring balance, and a firm but delicate hand, afford all necessary means of procuring quite satisfactory results, as to mere strength of material; while a careful inspection of the fractured pieces, after a little experience, will assist greatly in the determination of the general characteristics of the metal.



MACHINE FOR TESTING THE STRENGTH OF IRON.

3. The method of procedure is neatly illustrated in the large engraving, and would, in general, be as follows: Cut, from the bar or mass to be tested, pieces about three and a half or four inches long, and turn them off in the middle to a diameter of half an inch for iron or brass, and three eighths if of steel; make this neck one inch long. A square head is left at each end. Secure the piece vertically and firmly, by one end, in a strong vise; fit a solid ended wrench to the other end of the test piece; and to the extremity of the handle, which should be, for convenience, about five feet long, attach a spring balance capable of recording with accuracy up to fifty or sixty pounds.

Paint the scale of the balance with white lead or tallow, and spring the pointer so as to just touch the painted surface. The mark traced by the pointer then indicates the maximum force applied.



4. Commence pulling steadily on the balance, keeping the direction of pull at right angles to the wrench handle.

An apparently unyielding resistance will be felt up to a certain point, when the test piece will commence observably to give way. Note the indication of the spring balance at this point, which is the *limit of elasticity*, and record both that reading and, if possible, the distance through which the piece has twisted, the latter measure being an indication of its stiffness.

Continue twisting the piece until it has gone some distance beyond the limit of its elasticity, then stop and notice how far the arm springs back while gradually taking off the twisting force.

This distance is a measure of the *elasticity* of the metal, and is usually, if not invariably, the same, however great the set, even up to the point of rupture.

Renew the twisting force and break off the piece, noting the maximum angle which the piece has been twisted through and the maximum resistance, as indicated by the spring balance.

5. The *stiffness* of the metal is measured by the force required to twist it through the first small angle, say five degrees, should it yield so far without set. For half inch iron, this should be about fifty pounds on the end of a lever five feet long. For tool steel, it should be about thirty pounds, where the neck has a diameter of three eighths inch.

The *limit of elasticity* is determined by the force required to give it its earliest set.

The *degree of elasticity* is measured by the distance through which the wrench springs back when the force is removed after producing set.

The *ultimate tensile strength* is approximately proportioned to the force producing *rupture* by torsion.

The *limit of elasticity for tensile strength* is proportional to the force producing *set* by torsion.

The *ductility* of the metal is measured by the *angle* through which the piece twists before breaking.

The power of resisting shock, or *resilience*, as it is called by engineers, is nearly proportional to the product obtained by multiplying the breaking force by the maximum angle of torsion.

The *homogeneity* of the metal is determined by the regularity with which the resistance of the piece increases when passing its limit of elasticity.

6. By taking samples of well known brands of metals and pursuing this course, a standard is easily obtained, by reference to which a little practice will enable the experimenter to learn readily, and pretty accurately, the relative value of such other metals as he wishes to test.

7. Next, taking the fractured pieces, a careful inspection will assist wonderfully in pronouncing a correct judgment.

Thus, in our illustrations, No. 16 shows the side and the end of a fractured specimen of *wrought iron* of excellent quality, but seamy and not well worked.

The cracks extending around, in a spiral, through three fourths the circumference, and the appearance of irregularly distributed flaws on the end, prove the seamy character of the material, while the record of its test proves it tough, strong, and ductile.

Compare this with No. 22, which is the best piece of iron which could be found among a hundred tested specimens, and which is of almost wonderful toughness and ductility.

The surface of the neck, which, before being tested, was beautifully finished, has become greatly altered, and has assumed a curiously roughened and striated appearance. The spirals extend completely around the cylindrical portion, and the fractured end has the appearance peculiarly characteristic of very homogeneous and ductile metal. The record pencilled by the machine in this test shows it to have been fairly stiff, to have passed its limit of elasticity under a stress equivalent to about 30,000 pounds per square inch of tension, to have been more homogeneous than many specimens of shear or even than some cast steels, to have had a ductility exceeding that of any other specimen yet found of either iron or low steel, to have had a greater resilience, that is to say, power of resisting shock, than any other metal examined, and to have had an ultimate tensile strength of about 62,000 pounds per sq uare inch.

This metal was made of selected scrap from refined charcoal iron, rolled into half inch bars, cut and *polished*, and rolled down to one inch square. Such care must evidently produce a splendid iron. Unfortunately, however, it costs sixteen cents per pound.

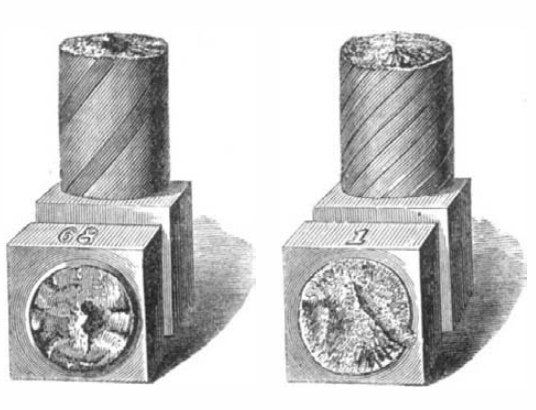
No. 1 is an iron of vastly different character. The record of the test shows it to be only a fairly good metal, and the end view exhibits a rough granular character of fracture, especially near the middle, and this proves its unreliability.

No. 23 is *cast iron* of a dark foundery grade, with a perceptible but slight ductility, and about half the strength of fair wrought iron.

The peculiar and almost mathematically regular form of the surface of rupture is noticeable in all irons of this class. No spiral markings are perceptible. The metal only yielded about ten degrees before fracture took place. Here the color and grain of the iron aid the judgment in forming correct conclusions after inspecting the record of test.

No. 30 is a hard white charcoal cast iron, such as is used for making "malleableized cast iron." It is a half stronger than the preceding, but is brittle, and has no ductility, snapping sharply at the limit of its elasticity.

8. No. 35 is the same white cast iron *malleableized*. Its test indicates undiminished strength, combined with ductility exceeding, by several times, that of the toughest grades of cast iron, and even equaling some kinds of untempered steel. It is far less ductile, however, than wrought iron. The fracture exhibits its incomplete transformation, and the irregular distribution of the remaining carbon.



No. 35 is also a sample of similar character but much more thoroughly malleableized.

The test exhibits a strength equal to that of quite good wrought iron, and a toughness which is not very much less than that of some hard forged iron. The fracture indicates a very regular character, and freedom from defects, while the spiral markings prove its ductility. Such a metal as this is better for many purposes than much of the wrought iron in the market, and the cheapness with which awkward shapes can be made of it, as compared with forgings, give it special advantages in many cases where the pieces are small.

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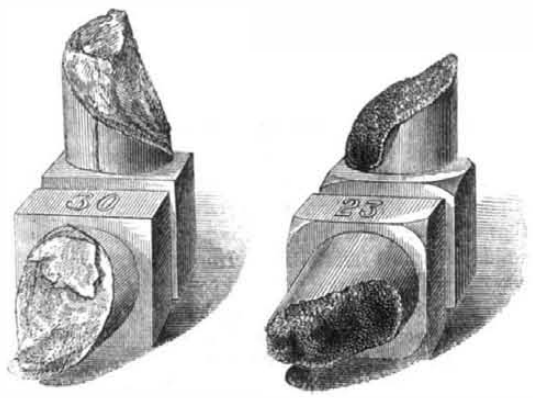
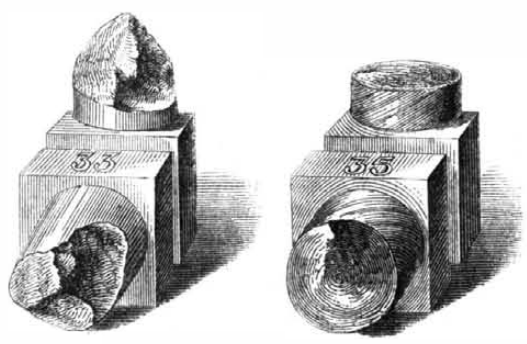
9. No. 68 is a specimen of low *steel*, and its peculiarities are those of "homogeneous" metal, or of steel made by either the Bessemer or the Siemens process. The test and an inspection of the fractured piece indicate its strength to be nearly double that of ordinary wrought iron, and prove its great ductility and resilience and its homogeneous character.

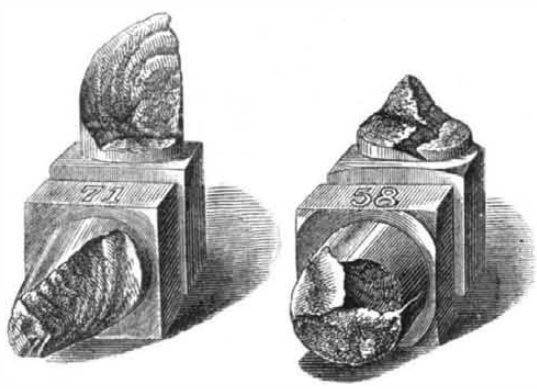


No. 71 is a piece of tool steel, having a strength twice as great as the best of iron, great elasticity, but a ductility only a fraction of that of good iron, excellent, in consequence of its strength and hardness, for tools and for resisting steady strain, but not so well adapted as steel of lower grade, or even as the better grades of iron, to meet shocks. Its jagged fracture and its fine even grain are evidence of the splendid quality of the metal and the perfect homogeneity of struc-



ture, which distinguish it from the fiberous wrought irons. The shear steels and the softer grades of tool steel usually exhibit an appearance very similar to 68, but are apt to crack along the side and through the neck, as is illustrated in No. 58.

10. Thus a little practice and careful observation will enable any good mechanic to test his materials even when he cannot afford to purchase a testing machine, and with a fair degree of confidence in the derived results, and at almost no expense.



A careful study of the accompanying illustrations, which the artist and engraver of the SCIENTIFIC AMERICAN have succeeded in making such perfect representations of the specimens placed before them, will assist greatly in the acquirement of this very valuable accomplishment.

Stevens Institute of Technology, Hoboken, N. J.
December, 1873.

The Vacuum Car Brake.

The vacuum car brake consists of a brass globe or bulb about fourteen inches long and five inches in sectional diameter in the largest part, and in shape very much like a lamp globe. The neck of the globe is about eight inches long. The enlargement is made to allow steam to surround a smaller pipe, which conducts the exhausted air. This part of the air pipe is about six inches long and two in diameter, reaching nearly to the neck of the bulb, leaving a space all around about one eighth of an inch wide; this tube is fitted tightly into the bottom of the globe so that none of the steam may escape below. To the lower part of this globe the air pipe is nicely fitted. In an enlargement of the end of this pipe, there is an air valve arranged to prevent the refilling the vacuum, and just below this is a relief valve to allow the air to enter. These valves are conical, so that the greater the pressure the more tightly they fit. Beneath each car, and connected with this apparatus by tubes, made so as not to collapse, is a cylinder with solid ends and flexible sides, which are kept from entirely collapsing by iron rings. The ends of this cylinder are connected with the brakes, so that, when the atmospheric pressure forces the ends together, the brakes are put on. The steam, being introduced from the boiler, passes out around the end of the air tube and removes the atmospheric pressures, producing a vacuum. By enlarging the cylinders beneath the cars, the power may be increased at pleasure.—*Polytechnic Bulletin.*

Ramming the Mold.

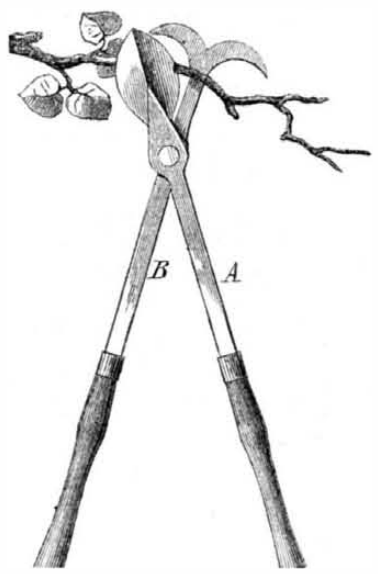
B. W. says: "In your number of November 22, 1873, you say that "ramming the mold is not a complicated performance, nor does it require the ability of a very skilled artisan." I have for many years been a close observer of losses in founderies, and I have found that about six tenths of the wastrels are on account of imperfect ramming, the latter being either too hard, causing the mold to blow and scale: or too soft, allowing it to strain as long as the metal retains its liquidity, and, when turned out, is too large to fit where it was intended. Hence the casting is condemned, in either case, on account of bad ramming. Any person posted in figures can calculate the pressure of fluids; but it requires the experience of years to know how much ramming is required to resist that pressure. He can only become skillful in the science of ramming by observing closely the result of every day's work, not only of his own, but of other molders also, so that he can ascertain the cause of any defect he may see on a casting, and thereby prevent the re-occurrence of the same. Ramming is a most complicated and important process; it amounts to but a very small portion of the cost of other work required to complete the job; but too hard, too soft, or irregular ramming, will cause all the work done on the job to be lost. The causes of the loss of the other four tenths are numerous, such as: Sand too wet, or too dry, inability of the molder to secure his mold before casting, lack of judgment in venting, lack of judgment in locating his gate to prevent warping and cracking in cooling, lack of judgment in stripping the casting so as to allow all parts of the casting to contract together, as that part of the casting that is allowed to contract last puts a great strain on a certain other part of the casting, and is likely to break it as soon as it is put to use. I hope the science of ramming will be further and more ably discussed in your valuable paper, and that you will be the means of getting molders to become more skillful with the ram, in which most valuable ability too many are lacking."

IMPROVED PRUNING SHEARS.

It is asserted that, to properly prune a tree, the limbs should be cut from the under side, and the blade should pass through them upon the outer side of the hook, resting upon the stump. In this way, horticulturists say, the end of the stump will not be splintered, and hence will be left in a better condition for rapid healing over.

Mr. Myron de Groodt, of Eaton, N. Y., has recently devised a pruning shears, acting on the above principle, by which the operator may cut off limbs upon opposite sides of the tree without shifting his position, on simply reversing the instrument.

The handle, A, connected with the blade, is grasped by the right hand, the handle, B, communicating with the anchor like hook with the left. In applying the shears, one of the arms of the hook is brought over the limb, and the handle, B, is held in a vertical position, while the other handle is elevated to open the jaws to a required distance. The blade then cuts through the limb from the under side and in an upward direction, with the hook bearing against the stump. To operate from the opposite side of the tree, it is only necessary to reverse the shears by simply moving the

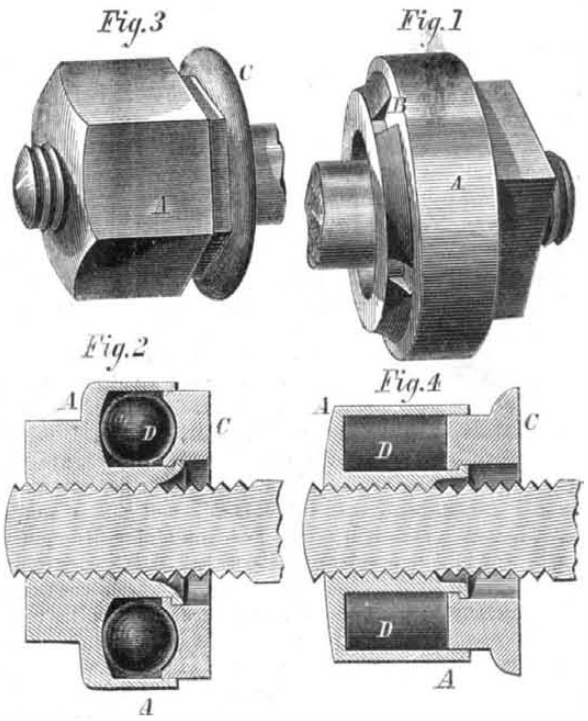


handles past each other without changing the hand, when the other edge of the blade acts with the hook precisely as before. In this way, the inventor says, a person may remain in one position and prune a tree nearly all around.

IMPROVED NUT LOCK.

The invention herewith illustrated is a new patent nut lock which, by the suitable combination with it of an elastic substance, is enabled to compensate for the longitudinal expansion and contraction of the bolt, thus preventing the nut from working loose under jars or shaking motions.

Our engravings represent two forms of the device as applied to railroad fish plates. In Figs. 1 and 2, which are perspective and sectional views between the two flanges, A A, is provided a chamber containing inside radial projections, B, which fit into corresponding notches in a washer, C. These notches and projections serve to lock together the nut so far as rotary motion is concerned, compelling the different portions to turn together. Into the chamber, between the flanges, A, are inserted a number of rubber balls, D, which are also received in suitable concavities in washer, C, Fig. 2. When the nut and washer are screwed together, it is evident that the balls are compressed and caused to spread until they fill nearly, if not entirely, the whole hollow space between the flanges, A. If the bolt becomes elongated by expansion, the balls take up the increase, through their own enlargement by elasticity, thus preventing the nut from working loose.

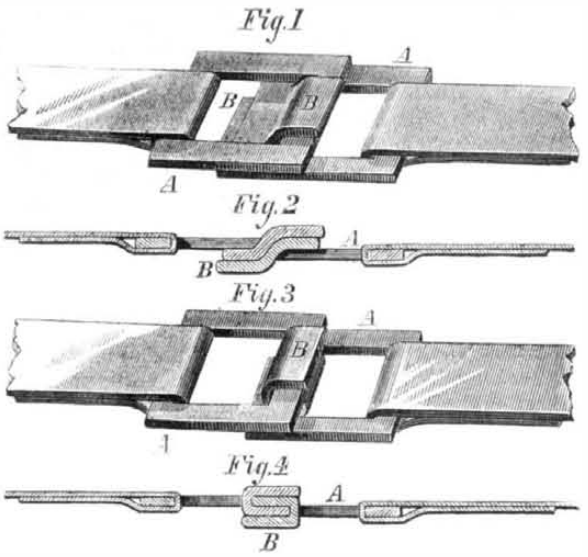


In Figs. 3 and 4, small cylinders of rubber are substituted for the balls, D, and the washer enters directly between the flanges. The tubular end of the nut is upset on the hole of the washer, in order to prevent separation of parts. The device appears simple and practical, and doubtless will meet with extended application upon railroads.

Patented November 25, 1873, by Casper Dittman. For further particulars address Dittman & Landis, Leacock P.O., Lancaster county, Pa.

STARR'S COTTON BALE FASTENER.

We illustrate herewith a very simple and ingenious device designed as a clasp or fastener for the bands which surround cotton bales. The invention is simply a square buckle of iron, A, having at its outer end a rigid tongue, B. Both sides



of the attachment are alike, so that, when the ends of the strap are brought together, the tongue of one buckle slips under that of the other, and interlocking takes place, as shown in Figs. 1 and 2. Figs. 3 and 4 are the same contrivance somewhat differently constructed, the tongue, B, being bent to form more of a hook. The device can be stamped or cut out of heavy sheet iron; and, if desired, a projection or stop may be combined with it to prevent the buckles slipping back after being once locked or hooked. The inventor states, however, that this latter precaution is entirely unnecessary, as a perfect double lock is afforded.

The mode of operating is as follows: After the bale is in the box, duly pressed, etc., the band is put on the top, hanging over in front with one of the buckles attached, hook out. The band is then brought under the bale, through the channel made for the purpose, and thence up to meet the attached backle, when it is bent back on the inside. Over this bent end the second buckle is slipped, hook in. The two buckles are then brought together and locked as before described. The strap, it is stated, will not detach itself until the bale is put in the compress, when it can be easily manipulated.

For further particulars address the inventor, Mr. Henry D. Starr, Texana, Jackson county, Texas.

WOMEN DENTISTS IN EGYPT.—Dr. Edward Warren writes from Cairo, in Egypt, to a friend in Baltimore, that there is "a good opportunity for women dentists in Egypt, as the women are forbidden to consult with men." There are three or four English women practicing dentistry in Cairo already, according to Dr. Warren's letter. In all these eastern countries, there seems to be a wide field of usefulness and profit for woman doctors and dentists.

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THE NEW EXPLORATION OF THE AMAZON RIVER, BY PROFESSOR ORTON.---OVER THE ANDES.

No. 6.

CHACHAPOYAS.

While most other towns in Northern Peru are but vast pig sties containing human habitations, Chachapoyas is the best built and cleanest city west of Manáos; its grand plaza and paved streets grant no indulgences to the lower animals. Perched 7,600 feet above the sea, it possesses a delightful and equable climate, with the mean temperature of 62° Fah. Here, for the first time since leaving New York, we saw bread made from native flour. Yet there is very little of that agriculture which requires a preparation of the soil: the people (to the number of 5,000) depend mainly on the voluntary gifts of Nature, scratching the ground with wooden plows to raise a little wheat, corn, potatoes, and rice. Six crops of rice can be raised without re-sowing. Flour sells for $10 a quintal; potatoes, 15 cents a pound; cleaned wool, 18 lbs. for $2; and cacao from the warmer regions at $30 a quintal. Nothing is exported but a little cascarilla bark. The best Indian tobacco grows at Bagua in the valley of the Utaubamba, and is sold at four reals for three pounds. The main woods for construction, cedar, walnut, ishpingu, and capuri, being brought a considerable distance, are very high. All boards, from Iquitos to the Pacific, are cut by hand. There are signs of valuable mines of gold, cinnabar, lead, limonite, and a gray copper ore containing silver, in the vicinity; while mountains of salt occur at San Carlos, twenty five miles northwest. Apple trees grow, but do not thrive, at Chachapoyas; the one we saw was covered with moss, yet it presented the singular spectacle of bearing blossoms and ripe fruit at the same time. Unfortunately, this city is the head center of the *garapáta*, a grublike insect whose bite not unfrequently leads to ulcers. If the road from Chachapoyas to the Marañon by the way of Olleros and the Aichiyacu, recently surveyed by Mr. Wetterman, is ever opened, it will bring the city into easy communication with the outside world.

From Chachapoyas to the next great city, Cajamarca, is about seventy miles. On the maps, this intervening country between the coast range and the central cordillera is represented as a broad valley; in the reality, it is a jumble of precipitous mountains. The road, for the first two days, is excellent, following the romantic Utcubamba and passing within sight of the lofty Cuelap mountain which is crowned with ruins too old to be Incarial.

A PRE-INCARIAL FORTRESS.

These are the ruins of a fortress, containing chambers and tombs, and consist of a wall of cut stone 560 feet thick, 3,600 long, and 150 high, above which rises another wall 500 feet thick, 600 long, and 150 high. It is estimated that it would take 20,000 men five years to build it. While the antiquarian is busy with this, the geologist may revel among ammonites and brachiopods; and on the third day, as the road rises above the clouds to the tiptop of Calla-calla, every traveller must be entranced by the magnificent panorama at his feet—a sea of mountains with the still loftier coast range in the background, hiding the Pacific. Descending from this frigid zone, by a fearfully inclined zigzag path, we soon reached the other extreme—a deep, narrow valley wedged in among the mountains, through which the Marañon struggles to reach its northern outlet. In making this descent, we passed over granite and mica schist, the first metamorphic rocks west of the Huallága, the other rocks east and west being sedimentary. This point, therefore, is the geological "Heart of the Andes."

The Marañon is crossed on a raft at the miserable mud village of Balzas, the temperature of which may be compared to that of a furnace. Here the river is from 250 to 500 feet in width according to season, with a six mile current. Again ascending, and crossing monotonous pajonals and the fertile pampas of Huanco and Polloc, we caught sight of famous Cajamarca, seated on the eastern slope of the western cordillera and fronting the most beautiful plain in all the Andes.

THE HEART OF THE ANDES.

This highland plain or campagnia, sixteen leagues in circumference, is almost as level as a billiard table, rich as the Connecticut flats, and well watered by the mint-bordered Chonta and Masscon. The roads crossing it are hedged in with century plants, and here and there rises the "sauci" (*salix humboldtiana*) the most conspicuous tree in the region. The surrounding mountains are barren and brown, but nevertheless are exceedingly picturesque.

CAJAMARCA AND ITS RELICS OF ATAHUALPA.

Cajamarca, the Caxamalca of Pizarro's day, claims to have 14,000 citizens; certainly it is the largest and finest city on our route from Pará to the Pacific. Its altitude is about 9,400 feet, and the temperature ranges from 40° to 72°. The houses are generally built of adobe, and tiled; but the churches are of the coarse conglomerate from the sierra, and have elaborately sculptured fronts. The grand plaza is adorned with a fine stone fountain, around which congregates a motley crowd of Indian women every morning to vend their little piles of vegetables, fruits, grains, meats, salt, pepper, etc., for the plaza is the "market place" in Spanish towns. The following are some of the prices current: Flour, $16 for 320 lbs.; corn, $1 for 26 lbs.; rice, $24 for 260 lbs.; coffee, $4.80 an arroba; cacao, $24 a quintal; tobacco, 50 cents per mazo of three or four pounds; sugar, $4 an arroba; cotton cloth, 10 to 20 cents per vara; wool, $1.20 to $2 an arroba; hides, $2 to $3 each; horses, $70 to $100 each; cows, $25 each; oxen, $40 each; sheep, $2 each; tiles, $16 a thousand; a cedar board, 2½ varas long by ¼ vara wide (say 7 by 2 feet), $5; land on the plains, $50 per "fanigada" of eight acres. Wheat, barley, corn, and potatoes are about the only vegetable productions within sight of the city. The province yields annually over 7,000,000 lbs. of wheat, 160,000 head of sheep, 30,000 head of cattle, and 16,000 horses. The manufactures amount to nothing; and the imports greatly exceed the exports in value. A few textile fabrics of wool and cotton are made, and some straw hats, from the "tamsi" instead of the "bombonaje." The celebrated silver mines of Gualgayoc, 18 leagues northwest, are not yet exhausted, but are not so productive as formerly.

Cajamarca occupies an important place in the history of Peru. It was the favorite residence of the Inca when his empire stretched from the Rio Andasmayo north of Quito to Rio Maula in Chili. The stone walls of his palace still stand for about 15 feet; and along the eastern edge of the plain a line of vapor indicates the "Baños del Inca." These hot springs, even now used for baths, are copious, but not medicinal; we found the temperature as they issue from the ground 162° Fah. The story goes that, when conquered by the Spaniards, the Peruvians threw the throne of gold of their Inca into a crater, from the sides of which came these thermal waters. The paved "via real" or military road, designed to connect Quito and Cuzco, stopped unfinished a little beyond Cajamarca. Its construction was interrupted by the landing of Pizarro or Tumbez, who garotted Atahualpa after receiving the ransom of "$16,000,000 gold and $175,000 in silver"—one of the many fictions of history.

Again we mounted our mules to scale the last cordillera which separated us from the Pacific. The range, as we crossed it westward, presented three main aspects: the eastern half was of quartzite, and the mountains comparatively smooth and rounded; then succeeded rugged rocks of trachytic porphyry. Here the landscape was purgatorial, presenting the confusion of the "grab box" of a geologist; volcanic piles, marine and river deposits, fiercely contorted granite dykes, etc, are huddled together as if Nature had been in a hurry. Finally, as we neared the ocean, there was a fine exhibition of the ceaseless conflict between sea and land; the barren, rocky mountains, upon which even the lichen refused to grow, stubbornly yielded to the supremacy of the older ocean; and as the great Andes died away along the shore, the southerly wind covered them with a winding sheet of sand.

AN AMERICAN ENTERPRISE.

Two days from Cajamarca, we shouted for joy at the sight and sound of a locomotive. It was the sign of civilization: the signal that our hardships were at an end. The Pacasmayo railway, now completed 54 miles from the coast, is a model of American enterprise and American skill. It is the creation of Mr. Meiggs, the Vanderbilt of Peru, and will cost $7,000,000. The money comes from the sale of guano; the laborers from China; the ties from Oregon and Chili; the rails from England; and the rolling stock from the United States. The buildings are of corrugated galvanized iron. The track is broad gage, and will have, when finished, a total length of 78 miles. Starting from an iron pier, which is to reach half a mile into the sea, the road winds over the pampa, and among the sand drives, and beside the Rio Jequetipeque, and through a region of intensest interest to the archæologist—crowded with the relics of Incarial cities and cemeteries—and ends near the silver mines of Chilate, at an altitude of 4,000 feet. These mines of Chilate, just opened, promise to rival those of Potosi. They yield an assay from $60 to $200 a tun.

Upon arriving at Pacasmayo, weary and worn by our long tramp over the mountains, we were received by the managers of the road, Messrs. Faulkner and Maynadier, and by Dr. Heath of the Hospital, with such unbounded hospitality that we are totally unable to "meet our obligations" and accordingly "suspend payment." Thrice happy the American traveler who can fall into such a fraternity at the close of his voyage.

JAMES ORTON.

Heat.

Professor Frederick Guthrie recently delivered a lecture to working men at the South Kensington Museum, London, on the above subject:

The lecturer showed that true gases expand nearly precisely the same fraction of their size for the same increase of heat, each cubic foot of gas at the freezing point of water becoming larger by three tenths and six hundredths when heated to the temperature of boiling water. An appreciable divergence from this rule occurs when we are dealing with a gas near its point of liquefaction.

Returning to the relative expansions of solids, a few practical applications were briefly considered, subh as the fusing of glass about platinum on making apparatus for the analysis of gas, or for passing electric sparks through confined gases. Inequality of expansion is also made use of in the gridiron or compensating pendulum. In this a copper bar is placed side by side with a shorter zinc bar, the lower ends being fastened together; the upper end of the zinc bar carries the bob, and the whole is hung from the upper end of the copper bar. The greater expansion of the shorter zinc bar upwards exactly counterbalances the lesser expansion of the longer copper bar downwards, and the center of oscillation remains a constant distance below the point of support, so that the rate of oscillation does not vary with the temperature. So a little rod of zinc, pointing inwards and fastened at one end to the circumference of the balance wheel of a watch, expands inwards as the wheel increases in size in warm weather, and makes the time of vibration constant. The watch become a chronometer. A certain quantity of mercury placed in a cylinder is also used, instead of the ordinary bob of a pendulum. The mercury expands more than the metal of which the rod is formed for equal columns, and therefore, by taking unequal columns, equality of expansion may be obtained. A most sensitive thermometer can be formed by availing oneself of the inequality of expansions of mercury and alcohol. A little platinum diving bell is partly filled with alcohol and placed in mercury, and provided with a slender platinum wire arising above the mercury. The whole floats. When the temperature increases, the alcohol expands more than the mercury. Some of the latter is driven out of the bell, and the latter rises; the motion of the exposed end of the platinum wire exhibits the rise.

As a rule, gases expand more than liquids and liquids, more than solids for the same increase of temperature; and so, according to the well known law of mechanics, we should expect to find the force of expansion of solids greater than that of gases. Accordingly the force exercised by expanding solids is almost irresistible. Iron rods are bent or snapped when their centers are pulled by contracting metals. A semi-solid mass, as glass, suddenly cooled becomes brittle. A drop of hot glass cooled in water becomes solid and rigid on its outside; then the inside cools and shrinks so that the whole, when cool, is in a condition of internal strain or unstable equilibrium. Disturbed in one place, the whole crumbles to pieces in its endeavour to assume the proper size due to itst emperature. The process of annealing depends upon the so gradual cooling of a soft body that the parts get to their proper distance. The bursting of pipes in winter time proves two things: first that the ice is lighter than water; and second, that the ice is almost incompressible. Water frozen in a bomb shell two inches thick will burst it.

The expansion of liquids by heat furnishes us with means for measuring temperature. An ounce of mercury immersed in freezing water always has a certain size. In boiling water, it always has another and greater size. And at any intermediate temperature, got by mixing together different proportions of freezing and boiling water, the mercury has an intermediate size. According, by measuring the size of any constant weight of mercury, we can tell what its temperature is. Thermometers are made by enclosing any convenient quantities of mercury or alcohol in glass bulbs, with very narrow stems, so that, when the liquid gets warm and expands, it may rise a considerable hight in the stems. Plunge such a bulb into freezing water, and the mercury shrinks in the stem to a certain point; plunge it into boiling water, it rises to a higher mark. The lower mark is is sometimes called 0° and the other 100° (C.), or 80°(R.), or the lower is called 32° and the higher 212°(Fah.) Water is at its greatest density at 4° C. If we take a flask full of pure water bearing a narrow stem and cool it from, say, 10° C., we find it shrink pretty regularly as it cool still it gets to 4° C. It then expands as it cools so that at 3° it is of about the same volume (and density) as at 5°, at 2° as at 6°, at 1° as at 7°, and at 0° as at 8°. It then freezes and swells in that act to a very great amount, measured by the proportion between the whole volume and submerged volume of a piece of floating ice. When a pond of water is freezing, the surface water is at 0°, the bottom at 4°, C.

Heat travels from point to point in space in three ways: (1), by conduction; (2), by convection; and (3), by emanation or radiation. It moves by conduction when the body which receives the heat does not move as a whole, but allows the heat to travel through it. Heat moves by convection when a hot body moves. It moves by radiation when a hot body gives off heat into empty space or into some medium which does not intercept it. The gradual heating from end to end of a poker in a fire illustrates the first of these methods, the flight of a red hot cannon ball the second, and the roasting of meat or the solar heat the third.

Metals, as a class, conduct heat better than any other class of bodies. Hence, when both are above blood heat, metals feel hotter than wood. When below, they feel colder. So that paper is scorched when heated in contact with wood, but not so easily when in contact with copper. Hence, also, lead may be melted in paper. Among the metals, silver and copper are pre-eminent. That copper conducts heat better than iron is shown by heating rods of the two at the plane of contact, and noting the melting of fragments of wax arranged along the two. The great conducting power of metals is shown by the cooling effect they have upon the mixed gases of a burning body. The metal withdraws so much heat from the gas in its neighborhood that combustion is impossible. The miner's lamp is based upon this principle.

Liquids conduct heat as a class worse than solids. The conducting power of liquids is measured by heating the upper surface of a film of liquid, and noting the expansion of the air in a chamber upon whose upper side the liquid film rests. The more complex the composition of a liquid is, the more opposition does it present to the passage of heat by conduction. Chlorine, iodine, and bromine are especially strong in resisting heat conduction. Water is by far the best conductor amongst non-metallic liquids.

Gases are far worse conductors than liquids, and the imperfect conduction of many solids is due to the gases, generally air, which they inclose in their pores or between their fibers. Clothing thus protects the body from loss of heat in cold weather and from the scorching heat of the sun in hot weather. A red hot ball may be carried in the hand if a mass of asbestos, which incloses the air, is interposed. Hydrogen conducts heat far better than other gases, and accordingly cools bodies in contact with it with great rapidity.

Gold may be readily cast; but it contracts so much in cooling that the process of casting is seldom employed in the arts.

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SCIENTIFIC AND PRACTICAL INFORMATION.

THE COMPANION OF PROCYON.

We noticed some time ago that Struve had discovered, by the aid of the magnificent refractor of the Pulkowa Observatory, a small star near Procyon, which he regarded as being the probable cause of the irregularities of the movements of the latter body. Dr. Andrews has since repeated his calculations regarding the proper motion of Procyon, which appears to be circular, in a period of a little less than forty years, around some invisible center. He does not now definitely conclude that to Struve's star should be ascribed this peculiar movement, but considers that the question will be decided next spring, if the new star is then visible. In such case, Struve's star should be at a considerable distance from the common center of gravity of both bodies, and a mass must be attributed to Procyon equal to eighty times that of our sun, and to his companion, a mass equal to six and two-thirds of the same body.

THE PURIFICATION OF TALLOW AND LARD.

Dr. Dotch states that tallow and lard can be kept from getting rancid by the following process: The tallow or lard is first treated with carbonate of soda in the proportion of 2 pounds of soda to every 1,000 pounds of lard, and is then subjected to a digestion with alum in the following manner: 10 pounds of alum are dissolved in 500 pounds of water, and 1 pound slaked lime added to the solution and boiled. This solution is stirred well with 1,000 pounds of lard at a temperature of 150° or 200° Fah. for about half an hour. The liquor is then separated from the lard, and the lard is treated with the same amount of pure water again. This lard will keep for an exceedingly long time. The fact is that the alumina in the alum applied acts very readily in a disinfecting manner upon those compounds which are liable to give rise to rancidity. The lime is added to the alum in order to render the alumina more active by its giving up some of the acid to the lime. This treatment has also the advantages of restoring the original flavor and of producing a lard of a greater whiteness.

ANILINE COLORS.

Professor Kopp, who has recently made a careful study of the aniline colors at the Vienna Exposition, says that the manufacture of these pigments from coal tar products is making most remarkable progress. Fuchsin, constituted by a salt of rosanilin, is obtained exclusively by the reaction of arsenic acid on commercial aniline. In order to afford an idea of the enormous consumption of this violent poison in the manufacture of fuchsin, it is stated that in Germany alone the same is estimated at 3,300,000 pounds a year. It is only lately that the residues have been treated to regain the arsenic in commercial form. M. Kopp mentions as a novelty a beautiful rose red coloring matter called saffronin, which upon silk is a very brilliant dye.

A NEW TEXTILE PLANT.

The ordinary wood nettle, as is well known to many of our readers, is found in profusion on the Alleghany mountains, often at a level of over 5,000 feet above the sea. A short time since, M. Rozel succeeded in transporting to Europe a number of living specimens of the plant, some of which he dispatched to the Prussian Minister of Agriculture, in order that the value of the weed, if any it had, might be determined. It appears that quite favorable results have been obtained in using the plant for textile purposes, and for such employment it is now attracting considerable attention in Germany. It is known botanically as the *laportea pustulata*, and is perennial. As it is, therefore, unnecessary to sow the seed each year, the plant has in this respect an advantage over hemp or flax, while it is stated to necessitate less labor and expense in preparing the fiber. In a wild state, the nettle attains a hight of two or three feet, but we learn that such as has been cultivated in Berlin has already exceeded this limit, and it appears possible that, by care and proper soil, even a still greater altitude may be gained. Experiments thus far made point to the fact that the plant will prove a not unimportant addition to our textile materials.

DECISIONS OF THE COURTS.

United States Circuit Court---District of California.

WATER CLOSET PATENT.—WM. SMITH *vs.* J. O'CONNOR *et al.*

[*In equity.—Before Sawyer, Judge.—Decision September* 1, 1873.]

A claim for "a receiver for pan water closets formed and constructed so that the side into which the pan swings for emptying will conform to the shape of the pan, etc., held, on comparing it with the specification, to be a claim not merely for a conformity, but for a conformity attained by specified means, and to be valid.

Held, also, on a like comparison with the specification, that the claim was not too broad.

A patent held not to be void for want of utility in the invention upon its appearing that it possessed certain advantages over others.

Although a third party had conceived of the invention before the plaintiff, and had made some progress toward completing a model, yet, if he then suspended his labors, and before he resumed them, the plaintiff had perfected the invention and had embodied it in a practical working machine, his patent will be sustained.

An invention will not be held forfeited in consequence of its having been on sale more than two years before the application was filed on which the patent issued, if within the two years the inventor had filed a previous application which described the invention, and was intended to cover it, although it was not specified in the claim in express terms. The second application will be considered a continuation of the first.

Supreme Court---District of Columbia.

PAPER FILE PATENT.—SMITH *et al. vs.* WOODRUFF.

[*In Equity.—Before Humphreys, Justice.—Opinion delivered Sept.* 13, 1873.]

Where two patents have been granted for articles which resemble each other, a presumption arises from the action of the Office that there is such a difference between them that the use of one constitutes no infringement of the patent for the other.

If one paper file holds the paper better than another which is patented, and has driven it out of market, that is *prima facie* evidence that the mechanism is different, and is a new invention and that the use of it does not violate the patentee's monopoly.

A patented combination may be used without infringing the patent if one of the elements of the combination is omitted, although another is substituted in its place which is new, or performs a substantially different function, or if it was not known as a proper substitute when the patent issued.

Although a bill for restraining the infringement of a patent is dismissed, the defendant will be allowed no costs if the rights of the parties are thereby settled, and a benefit consequently results to him as well as the public.

W. E. Edmonds, attorney for plaintiff.
R. D. Mussey, attorney for defendant.

United States Circuit Court---Eastern District of Missouri.

TRUSS BRIDGE PATENT.—JAMES V. WESTLAKE *vs.* M. S. & H. B. CARTTER.

[*Before Treat, Judge.—Decided October* 11, 1873.]

It is not sufficient to give notice of special matter of defense in an action upon a patent thirty days before the trial; it must be given thirty days before the first day of the term.

Such notice need not specify the particular portion of the plaintiff's patent to which the evidence applies.

Patents may be given in evidence to show the state of the art without such notice; but printed publications cannot be.

The proceedings in the Patent Office upon the plaintiff's application for the patent are not admissible for the purpose of giving it a different construction.

If the defendant claims that the patent is void for uncertainty, it rests with him to establish the charge.

The patent is not void for want of utility, if the invention possesses it in any measure, however slight.

A combination may be patentable on account of the novelty of the arrangement, although all the elements are old.

A patent for a combination is not infringed unless all the elements enumerated are used, or the equivalents of those which are omitted are substituted for them.

To show that the parts omitted by the defendant from a patented combination are unessential, will not render him liable as an infringer for the use of the rest.

A device is the equivalent of one that is patented if it performs substantially the same function in the same way and produces the same result, though it may be of a different form and bear a different name; and the use of it will be an infringement.

If the defendant has a patent, it is evidence of the opinion of official experts that it does not conflict with the plaintiff's patent, and that in working under it he is guilty of no infringement.

Such evidence will be submitted to the jury; the court will not compare the patents.

If the patentee is engaged in manufacturing the patented article for sale, his damages will be manufacturer's profits.

Verdict for defendants.
M. Kinealy for plaintiff.
Samuel S. Boyd, for defendants.

NEW BOOKS AND PUBLICATIONS.

THE OVERLAND MONTHLY for January has, among other interesting papers, an article by Professor George Davidson on the "Abrasion of Our North Western Coast," in which the remarkable table lands or *mesas*, in that portion of the country, are described. As an explanation of the origin of these peculiar formations, the writer thinks we can appeal to the "action of ice moving slowly but surely as a great planing or molding machine. If we accept an ice sheet over the continent, or a part thereof, and an ice belt contiguous to the continental shores, we can readily understand that it moved as a great stream, or, more likely, in currents, from the north." The second of these papers, on "New Zealand," contains some fresh information regarding that little known country. The "Japanese Merchant at Home" and "Summering in the Sierras" are pleasing descriptions, entertaining and readable. The usual selections of poetry, editorial miscellany etc., complete a table of quite varied and interesting contents. Published by John H. Carmany & Co., 409 Washington street, San Francisco, Cal. $4 a year.

Value of Patents,

AND HOW TO OBTAIN THEM.

Practical Hints to Inventors.

PROBABLY no investment of a small sum of money brings a greater return than the expense incurred in obtaining a patent even when the invention is but a small one. Larger inventions are found to pay correspondingly well. The names of Blanchard, Morse, Bigelow, Colt, Ericsson, Howe, McCormick, Hoe, and others, who have amassed immense fortunes from their inventions, are well known. And there are thousands of others who have realized large sums from their patents.

More than FIFTY THOUSAND inventors have availed themselves of the services of MUNN & Co. during the TWENTY-SIX years they have acted as solicitors and Publishers of the SCIENTIFIC AMERICAN They stand at the head in this class of business; and their large corps of assistants, mostly selected from the ranks of the Patent Office: men capable of rendering the best service to the inventor, from the experience practically obtained while examiners in the Patent Office: enables MUNN & Co. to do everything appertaining to patents BETTER and CHEAPER than any other reliable agency.

HOW TO OBTAIN *Patents.* This is the closing inquiry in nearly every letter describing some invention which comes to this office A *positive* answer can only be had by presenting a complete application for a patent to the Commissioner of Patents. An application consists of a Model, Drawing, Petition, Oath, and full Specification. Various official rules and formalities must also be observed. The efforts of the inventor to do all this business himself are generally without success. After great perplexity and delay, he is usually glad to seek the aid of persons experienced in patent business, and have all the work done over again. The best plan is to solicit proper advice at the beginning If the parties consulted are honorable men the inventor may safely confide his ideas to them, they will advise whether the improvement is probably patentable, and will give him all the directions needful to protect his rights.

How Can I Best Secure my Invention?

This is an inquiry which one inventor naturally asks another, who has had some experience in obtaining patents. His answer generally is as follows and correct

Construct a neat model, not over a foot in any dimension—smaller if possible—and send by express, prepaid, addressed to MUNN & Co., 37 Park Row New York, together with a description of its operation and merits. On receipt thereof, they will examine the invention carefully, and advise you as to its patentability, free of charge. Or, if you have not time or the means at hand, to construct a model, make as good a pen and ink sketch of the improvement as possible and send by mail. An answer as to the prospect of a patent will be received, usually, by return of mail. It is sometimes best to have a search made at the Patent Office. Such a measure often saves the cost of an application for a patent.

Preliminary Examination.

In order to have such search, make out a written description of the invention, in your own words, and a pencil, or pen and ink, sketch. Send these with the fee of $5, by mail, addressed to MUNN & Co., 37 Park Row, and in due time you will receive an acknowledgment thereof, followed by a written report in regard to the patentability of your improvement. This special search is made with great care, among the models and patents at Washington, to ascertain whether the improvement presented is patentable.

Rejected Cases.

Rejected cases, or defective papers, remodeled for parties who have made applications for themselves, or through other agents. Terms moderate. Address MUNN & Co., stating particulars.

Caveats.

Persons desiring to file a caveat can have the papers prepared in the shortest time, by sending a sketch and description of the invention. The Government fee for a caveat is $10. A pamphlet of advice regarding applications for patents and caveats is furnished gratis, on application by mail. Address MUNN & Co., 37 Park Row, New York.

Trademarks.

Any person or firm domiciled in the United States, or any firm or corporation residing in any foreign country where similar privileges are extended to citizens of the United States, may register their designs and obtain protection. This is very important to manufacturers in this country, and equally so to foreigners. For full particulars address MUNN & Co., 37 Park Row, New York.

To Make an Application for a Patent.

The applicant for a patent should furnish a model of his invention if susceptible of one, although sometimes it may be dispensed with; or if the invention be a chemical production, he must furnish samples of the ingredients of which his composition consists. These should be securely packed the inventor's name marked on them, and sent by express, prepaid Small models, from a distance, can often be sent cheaper by mail. The safest way to remit money is by a draft, or postal order, on New York, payable to the order of MUNN & Co. Persons who live in remote parts of the country can usually purchase drafts from their merchants on their New York correspondents.

Reissues.

A reissue is granted to the original patentee, his heirs, or the assignees of the entire interest, when, by reason of an insufficient or defective specification, the original patent is invalid, provided the error has arisen from inadvertence, accident, or mistake, without any fraudulent or deceptive intention.

A patentee may, at his option, have in his reissue a separate patent for each distinct part of the invention comprehended in his original application by paying the required fee in each case, and complying with the other requirements of the law, as in original applications. Address MUNN & Co 37 Park Row, for full particulars.

Design Patents.

Foreign designers and manufacturers, who send goods to this country may secure patents here upon their new patterns, and thus prevent others from fabricating or selling the same goods in this market.

A patent for a design may be granted to any person, whether citizen or alien, for any new and original design for a manufacture, bust, statue, alto relievo, or bas relief; any new and original design for the printing of woolen, silk, cotton, or other fabrics; any new and original impression, ornament, pattern, print, or picture, to be printed, painted, cast, or otherwise placed on or worked into any article of manufacture.

Design patents are equally as important to citizens as to foreigners. For full particulars send for pamphlet to MUNN & Co., 37 Park Row, New York.

Foreign Patents.

The population of Great Britain is 31,000,000; of France, 37,000,000: Belgium, 5,000,000; Austria, 36,000,000: Prussia, 40,000,000; and Russia, 70,000,000. Patents may be secured by American citizens in all of these countries. Now is the time, while business is dull at home, to take advantage of these immense foreign fields. Mechanical improvements of all kinds are always in demand in Europe. There will never be a better time than the present to take patents abroad. We have reliable business connections with the principal capitals of Europe. A large share of all the patents secured in foreign countries by Americans are obtained through our Agency. Address MUNN & Co., 37 Park Row, New York. Circulars with full information on foreign patents, furnished free.

Value of Extended Patents.

Did patentees realize the fact that their inventions are likely to be more productive of profit during the seven years of extension than the first full term for which their patents were granted, we think more would avail themselves of the extension privilege. Patents granted prior to 1861 may be extended for seven years, for the benefit of the inventor, or of his heirs in case of the decease of the former, by due application to the Patent Office, ninety days before the termination of the patent. The extended time inures to the benefit of the inventor, the assignees under the first term having no rights under the extension, except by special agreement. The Government fee for an extension is $100, and it is necessary that good professional service be obtained to conduct the business before the Patent Office. Full information as to extensions may be had by addressing MUNN & Co., 37 Park Row.

Copies of Patents.

Persons desiring any patent issued from 1836 to November 26, 1867, can be supplied with official copies at a reasonable cost, the price depending upon the extent of drawings and length of specification.

Any patent issued since November 27, 1867, at which time the Patent Office commenced printing the drawings and specifications, may be had by remitting to this office $1.

A copy of the claims of any patent issued since 1836 will be furnished for $1.

When ordering copies, please to remit for the same as above, and state name of patentee, title of invention, and date of patent. Address MUNN & Co., Patent Solicitors, 37 Park Row, New York city.

MUNN & Co. will be happy to see inventors in person, at their office, or to advise them by letter. In all cases, they may expect an *honest opinion.* For such consultations, opinions, and advice, *no charge is made.* Write plainly: do not use pencil, nor pale ink; be brief.

All business committed to our care, and all consultations are kept *secret and strictly confidential.*

In all matters pertaining to patents, such as conducting interferences, procuring extensions, drawing assignments, examinations into the validity of patents, etc., special care and attention is given. For information, and for pamphlets of instruction and advice

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OFFICE IN WASHINGTON—**Corner of F and 7th streets,** opposite Patent Office.

Recent American and Foreign Patents.

Improved Track Clearer.

Frederick Buse, Fergus Falls, Minn.—This invention consists in two wheels arranged in front of the cowcatcher of a locomotive and in a plane perpendicular to the direction of the track. By suitable gearing, these are connected with the forward axle so that the wheels are swiftly rotated, causing radial wings or shovels attached thereto to throw and blow the snow from the track, and thus work their way rapidly through the snow even should it be greatly drifted.

Improved Hoop Lock.

Thomas E. Lucas, Chesterfield, S. C.—The object of this invention is to provide a way for fastening or tying the ends of wooden hoops together for barrels, tubs, and other cooper work, and for other purposes, and it consists in a metallic tie having two sockets connected together, in which sockets the ends of the hoops are wedged.

Improved Cherry Stoner.

Eli Buck and Edgar W. Kirk, Cincinnati, Iowa.—By suitable construction, as punches descend upon the cherries in tapering holes, the stones are punched out of the fruit and through the holes, and fall into a dish placed beneath the said holes. As the punches ascend they carry the fruit with them up to a plate having holes in it, through which the punches pass but not the fruit, so that the latter is pushed or stripped from the said punches. As the punches ascend, the pan moves back so as to pass beneath the punches and receive the fruit as it falls from the plate. The fruit slides down the pan into a dish placed beneath the lower end of said pan. The descent of the cherries in the pan is regulated with one hand, while the crank is turned with the other.

Improved Cotton Gin,

Nicholas W. Gaddy, Nichols, S. C.—This invention is an improvement in the class of gins having auxiliary bars or fingers applied to the ordinary bars or fingers between which the saws revolve; and the invention consists in the arrangement of short secondary fingers so as to be readily attached and detached, and to be shifted or moved toward the saws from time to time, as they wear smooth at the corners, thus exposing new and sharp edges.

Improved Ticket and Delivery Holder.

Leonard J. Blades, Harrington, Del.—This invention relates to fare boxes, and consists in providing a lock case with sliding drawers which are partitioned off, inclined, and caused to allow the exit of the tickets one by one.

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Improved Door Spring.

Henry Cody, New York city.—There is a casing of cast iron which contains the springs and jaws. The ends of the jaws clasp a central stud and a transverse plate on top of the stud which holds the jaws in place. The lower end of a shaft turns on a pivot on the bottom of the case, and has a roller on the end of an arm. The end of the shaft extends up above the top plate, and is rigidly attached to a lever. The jaws are forced toward each other by a circular spring which exerts a constant pressure. The lower end of the door is rigidly connected with the lever. When the door is swung open, it carries the lever and arm with its friction roll, which spreads the jaws one from the other. The jaw becomes a lever of constantly increasing power, the fulcrum being the stud and the spring the resisting point. When the door has made a quarter circle or is wide open, the roller will be carried to near the outer end of the jaw, and the arm will be parallel with the door. In this position the spring will bear directly against the axis, and the door will remain stationary. Should the door be left at any intermediate point, it would be closed by the spring. By means of this apparatus the ordinary butt hinges are dispensed with. The door is held open when desired, and is self-closing at all times when not wide open.

Improved Hand Corn Planter.

Eli Rogers, Rochester, N. Y.—A cap is placed upon the lower part of the seed box, where it is secured in place by two spring catches which pass up on the opposite sides of the lower part of the hopper and catch in notches formed in the sides. The lower part of the cap is formed by two parallel plates, one of which is stationary and the other pivoted. To the upper part of the pivoted plate is attached a hook which hooks upon a crank. Upon the crank shaft is formed an arm, to the outer end of which is pivoted the lower end of a connecting rod. With this arrangement the plates, which are pressed close together by the action of the spring, are forced into the soil, and the rear end of a lever is drawn upward or toward the handle. This movement operates the slide and drops the seed and plaster by spreading the plates apart. As the lever is released the spring moves the various parts of the machine back to their former position.

Improved Fertilizer Distributer.

James Lytch, Laurinburg, N. C.—This invention is a machine for opening a furrow and distributing guano in it preparatory to planting cotton or other seed, simple in construction, convenient in use, and reliable in operation. The invention consists in the shoe provided with a spout held in pivoted suspension bars, so as to allow the shoe to have a backward and forward movement. In the shoe is formed a hole, through which the guano escapes to the ground through the spout, which is designed to guide the guano into the furrow, and prevent it from being blown about by the wind. The rear part of the shoe is supported by a cord, so that the inclination of the shoe, and consequently the rapidity of discharge, may be increased and diminished by unwinding the cord from and winding it upon a knob. A wheel is placed directly in the rear of the conduction spout and is made with a deep V-shaped groove in its face, and with a number of rods crossing said grooves near the periphery of the wheel. As the wheel revolves, each rod pushes the lower end of a spring forward, which end, as it escapes from said rod, springs back against the next rod, this jarring the shoe, and insuring the constant and regular discharge of the guano. The amount of guano escaping from the hopper is also regulated by a slide. By suitable construction, by operating a lever, the lower part of the spring is thrown forward away from the rods of the wheel, to allow the shoe to stand still, and thus enable the distribution of guano to be stopped when desired.

Improved Door Check.

Jacob Bader, Olathe, Kansas.—This invention consists of a pair of legs jointed together and to a slide on the door or gate, so as to be shoved down on the floor or ground, and at the same time extended from each other in both directions in which the gate or door swings, so that by bearing on the floor or entering the ground they will hold the door or gate from swinging. In the case of a door, the legs and slide will be arranged in a recess in the edge extending upward a suitable distance from the lower corner, so as to be worked up and down by hand, and will have a set screw to fasten it; but in a gate the legs, being similarly arranged in a recess on the end post of the gate frame, may be worked by a lever, with which buttons are arranged to hold it in the position for keeping the legs in the ground or out of it.

Propelling Canal Boats and Other Vessels.

Louis Bastet, New York city.—This invention consists in propeller wheels combined with close channels inclined downwardly from bow to stern, and receiving the water from the surface in front of the boat and discharging it at the rear, whereby the surface waves from the front of the boat, that tend to cause the washing of the banks, are prevented.

Improved Hand Corn Planter.

Michael P. Nemmers, St. Donatus, Iowa.—The outer case of the corn planter is of oblong shape, and the remainder half prism, base upward. A vertically sliding plunger extends through the full length of case along the rear side of the same. The plunger has at its upper end a handle, and at its lower end a metallic piece with sharp edge to enter the soil and carry the seed before it. On it there is a spring plate, placed diagonally to act with a cam movement on the teeth of a horizontal revolving seed cup disk. Above the latter another cam spring, diagonally placed in the contrary direction, completes the distributer. The corn chamber is arranged in the upper part of case. A vertical slide piece has an inclined end for the purpose of admitting a smaller quantity of corn to the revolving disk, and taking off the weight of the corn from the same, making thereby its motion easier and quicker. The revolving distributing disk is perforated by a certain number of holes of such size as to admit freely the seed or corn. A double row of vertical brushes is arranged to allow the seed to fill the holes to the rim, and to brush off the other seed to drop into the other holes when the same are approaching toward them by the revolving of the disk. By suitable adjustment the amount of seed passing to the distributer disk may be regulated. The seeds pass down as each hole discharges its contents into the lower part of the planter, dropping on an inclined band spring. The seed is then carried into the ground by the descending plunger end. The spring action of the band presses its end firmly against the plunger, so that no seed can escape. It serves, also, on the upward motion of plunger, as a scraper to clean the same from the adhering dirt. The depth to which the plunger is intended to penetrate the ground and deposit the seed can be adjusted as the different soils require it.

Improved Knife Cleaner and Polisher.

Cevedra B. Sheldon, New York city.—This invention consists in the improvement of knife cleaners by the introduction of a spring-pressed holder provided with a horizontally slotted top piece, and combined with a lever having a side pivot working in slot. By this improvement, a knife drawn back and forth a few times not only comes out perfectly clean but beautifully polished.

Improved Car Axle Lubricator.

James E. Bering, Newburgh, N. Y.—This invention relates to means for lubricating the parts of a car axle journal, whereby the surface of the flange and the body of journal are automatically provided with a graduated supply of oil or lubricating substance.

Improved Adjustable Bench Vise.

Jeremy B. Wardwell, Lawrence, Mass.—This invention is a bench jack for carpenters' and cabinet makers' use, for holding boards while being jointed. A bar is slotted to receive the jaw, and has notches to receive the pawl, by which the jaw is supported when adjusted. The jaw has ratchet teeth formed upon its upper side. The shank also passes through the frame, the forward end of which is so formed as to fit and slide upon ways formed upon the rear side of the ratchet bar. By suitable construction the shank of the jaw holds a piece in place in the frame, which forms a rest and also holds the frame in place upon the rear side of the ratchet bar. To the forward end of the piece is pivoted a pawl, which is so formed that its own weight may hold its lower or engaging end against the notched forward side of the bar. The pawl thus supports the rest, the frame, and the jaw, in any position into which they may be adjusted, the said parts all moving together. There is also other mechanism which allows the jaw to be more accurately adjusted to the thickness of the board to be held. In using the device, the ratchet bar is secured to the bench at a proper distance from the vise, and the jaw is adjusted at the proper hight to receive the board. The board is then arranged in place and the jaw pushed in against the side of the said board.

Improved Grain Hulling Machine.

Oren F. Cook, Grand Island, Cal.—This invention relates to a process for removing from grain its outer husk or bran, and it consists, first, in subjecting the grain after the ordinary cleaning to the action of water or steam, to soften the husk, then passing it between two roughened metallic surfaces, one revolving within the other.

Improved Boat Gripe and Crane Keeper.

Francis M. Howes, Somerville, Mass.—This invention relates to the gripes and cranes used on board of a vessel for the purpose of handling the boats, and consists in combining a lever having clamp and hook chain with a single chuck to hold the boat in position on deck, and allow it to be easily detached, swung out, and let down into the water.

Improved Match Box.

Morris L. Orum, Philadelphia, Pa.—The object of this invention is to provide safe and convenient receptacles for matches, connected with the gas burner bracket; and it consists in the match safe combined with the bracket, which was described and illustrated on page 342 of our last volume.

Improved Corn Planter.

Andrew Springsteen, Oquawka, Ill.—By suitable arrangement a plate not only serves as a guide for the corn, but at the same time the alternating movement of a roller gives to the said plate an up and down movement, so that it may push out any dirt that may enter the interior of the standard. A stirrer passes through a hole in the side of the hopper, so that the stirrer may move back and forth in the hopper above the discharge opening, and thus keep the corn stirred up, so that it cannot clog and will pass out freely. The stirrer moves back and forth close to the upper side of the dropping roller, so as to operate as a cut off to prevent any more seed than enough to fill the dropping recesses from being carried out by said roller. Covering plows or wings, which are attached to the sides of the lower end of the standard, are formed to guide the soil into the furrow at the rear of said standard and cover the seed.

Improved Middlings Purifier.

George Parker, Poughkeepsie, N. Y.—On the top of a rectangular case, near one end, is a funnel-shaped receiver, which is to be placed directly under the floor on which the pile of middlings lies, the floor having a hole as large as the top of the funnel, or thereabout. In the opening of the funnel is a revolving cone feeder nearly filling the opening. This cone, which is adjustable vertically to open the passage more or less, is provided with grooves in the sides, which facilitate the feeding by scraping off the mass lying upon the cone regularly, and producing an even stream. It is revolved by gearing at the lower end, connected with the main driving shaft. Immediately under the cone is a flat shaking sieve hung by hooks at the upper end to the wall of the case, and at the lower end resting on the cams, which lift it and let it fall at each revolution. At the lower end the coarse matters escape, to be blown out of the case by the blast from the fan, but the finer portions fall through the sieve on the returning chute attached to the under side of the sieve, and descending toward the upper end of the next sieve below, on which it discharges. This sieve is like the one above, except it is a little finer. The coarse light matters from the lower sieve also escape off the end, and are blown out of the case. These are again separated into two grades by the plates and a passage which turn the heavier portions downward, while the lighter portions pass over and beyond.

Improved Rotary Engine.

Peter Worrall, Sugartown, Pa.—The steam enters successively into two cylinders both fast to the main shaft and in each of which is a piston wheel. Each wheel has three pistons, so that two are always under steam pressure when the third one is taking steam. The pistons are of peculiar construction, being longitudinal sections of a cylinder, with a circular head at each end, upon which are journals, to the latter of which a crank is attached. When the pistons reach the abutments, they are turned so as to fit into the cavities. As they leave the cavity, they are directly turned so that the broad and more flattened sides take steam, thus making the steam surface or area of the piston greater than the area of the cylinder. The steam is introduced into the first cylinder from below, the valve being operated by means of a lever, which is held in position by means of a spring lever and circle. The exhaust aperture opens from the second cylinder. The intermediate valves between cylinders are placed back of the abutments, and are operated by means of the ribs on the plates of the piston wheels. The ends of the valves project inward, and are triangular in cross section. As the wheels revolve, the end of the ribs strikes one of the angles, and turns the valve so that the ports admit and exhaust steam. It will be seen that the steam, after doing work, and, consequently, losing a portion of heat and pressure in the first cylinder, is exhausted into the second cylinder, where it acts upon the pistons in the same manner, doing more work, and parting with a large portion of its remaining heat and pressure.

Improved Fire Place.

William Hoyland, Newcastle, Pa.—A couple of side plates are set upright in a groove in a cast metal bed plate, said plates being curved to correspond with the said groove. They are arranged on opposite sides of the bed piece, to rest at the back against the partition wall, being about as wide as the thickness of the wall, and as high as the fire place is to be. They are fastened in the groove, at the lower end, by a flange. The fire grate is a round basket fitting the side plates, and mounted on a pivot so as to turn freely. It has a partition of fire brick dividing it as high as the back plates, of which there is one for each room. The grate, together with its partition can be turned so that one fire in one part of the grate will warm both rooms or it can be turned half way around, and thus change the fire from one room to the other, which may be desirable when only a little heat is required for ventilating the rooms, or when the temperature is not very low.

Improved Nut Lock.

Charles A. Howard, Pontiac, Mich.—Four nuts are locked by this invention. This is the number of bolts usually employed for securing fish plates to rail joints. The end of the plate locks the first nut. The second nut is inclosed by a square hole in the plate. The third nut is locked by a lock plate, and the fourth nut by the end of the lock plate, or by both. The end of the spring plate extends sufficiently far to form a spring, and is reduced in width, so that it passes through a slot or hole in the locking plate. By raising the end of the lock plate to a right angle, the third nut is unlocked and the spring plate can be removed without difficulty. The tension of the spring of the spring plate holds the locking plate in place.

Button Hole Stitching Attachment for Sewing Machines.

Carl A. Hansen and George Harley, Guelph, Canada.—This invention consists of apparatus mounted on a frame arranged to be attached to the head of a sewing machine, and connected to the needle bar to be operated. The device is arranged to cause a hook to pass down through the throat plate, and engage the thread immediately after the shuttle has passed through the loop, draw it up through the button hole, and present it to a pusher, which, by a portion of said apparatus, is caused to carry the loop beyond the needle, and hold it until the needle goes down through it and completes the stitch.

Improved Clothes Wringer.

John Seaman, Groton, N. Y.—The journals of the rolls work in slots in the standards, and upon the journals of the upper roll are placed half bearings, upon which rest the ends of the curved spring, the middle part of which is attached to the top bar. To one journal of each roll is attached a gear wheel, the teeth of which mesh upon a circle of pins or cogs attached to the side of a disk or wheel attached to the other journals of the rolls. The gearing, thus constructed, gives greater capacity to the machine, or allows the rolls to work closer together or farther apart without binding or getting out of gear. Upon the edge of the gear wheel of the lower roll is formed an outwardly projecting flange upon the inner surface of which are formed gear teeth, into which mesh the teeth of the small pinion wheel, attached to the crank shaft, which works in a long bearing in a bracket attached to the standard. This construction is claimed to give a greatly increased power to the wringer.

Improved Bird Cage.

Edward Hutchinson, New York city.—This invention consists of a perch for bird cages, constructed in two parts, which are tongued and grooved together so as to form a very narrow crack along each side, such as insects and vermin, which infest birds, like to hide in, and so that the two parts of the perch can be readily taken apart to destroy the insects, when the perch is removed from the cage.

Improved Garden Cultivating Implement.

David Mack, Barnesville, Kan.—This invention is an improved implement for use of gardeners, nursery men, etc., for cultivating various plants by hand. It includes a shovel or plow, rake, weed cutter, clod-breaking roller, and an adjustable transporting wheel. The plow is made double, one end being made small and the other large, so that one or the other end may be used, according as the work to be done may require. The forked shank of the rake is bolted to the standard. The blade of the weed cutter is made V shaped, and is secured to the ends of the arms of the shank, which is, in turn, secured to the standard by the same bolt that secures the plow. The same means secure the roller by its shank. The function of the rake is to clear the surface of vines, weeds, etc., whose roots or stems may have been severed by the cutter. The roller is used by the weed cutter and rake, principally for the purpose of preventing the former entering the earth too far or sustaining too much of the weight of the frame of the implement. The shovel is detached when the weed cutter is used, or else turned so as to be crosswise of the standard. Similarly the weed cutter is detached when the shovel is used.

Improved Machine for Drawing Wire.

Joseph Woods and Edwin Woods, Warrington, Great Britain.—The apertures in the plates or dies are of successively decreasing diameters, the last being of the proper size for bringing the wire to the intended gage, and the numbers of teeth in the pinions are so proportioned as to cause the pulleys and block to rotate at an increased surface speed in proportion to the attenuation of the wire. Motion being now communicated to the main shaft, the wire is drawn by the pulley successively through the different dies, the numbers of teeth in the pinions being, as explained, in such proportions as to enable the pulleys to take up the increasing length of wire. Instead of the pulleys being of the same diameter, arranged to be driven at different speeds as regards their revolutions, they might be of diameters increasing toward the block, in which case the series of bevel pinions might be furnished with equal numbers of teeth; further, instead of one pulley being used for each draw plate or die and the wire wound around such pulley, a series of small pulleys (say, three) might be employed, the wire passing alternately under and over them, so as to provide sufficient surface for holding contact with the wire. The surface speeds of the pulleys and block will be required to be varied in practice for obvious reasons, such as when drawing wire of iron, steel, or brass; but the adjustment of the said pulleys and block, so as to provide a correct surface velocity will be simple to practical wire drawers.

Improved Door Spring.

Francis H. Richards, New Britain, Conn.—A tube is pivoted to a bracket attached to the casing, and supported by a second bracket passing through a slot in its bottom and secured to the door. In the rear part of the tube is placed a coiled spring of sufficient strength to shut the door quickly and with a slam, if allowed to act freely. The forward end of the spring rests against a piston, which is attached to the end of the door bracket, so as to move back and forth through the tube. The piston is made of such a size as to slide freely through the tube, and to its forward end is attached a cupped packing, made of leather or other suitable material, and which moves freely through the tube as the piston moves toward the rear end of the said tube, and which, when the piston moves forward, serves as a valve to push the air forward, and thus cushion the piston upon compressed air, so as to check the door just before it closes, and thus prevent it from slamming. The air escapes through the forward end of the tube, where its escape is regulated by a grooved screw.

Improved Steam Engine.

Abram Beekman, of New York city.—Part of the boiler constitutes a wheel case, in which there is a wheel to which the steam is delivered to the boiler through a passage on one side of the vertical center of the wheel, to give the steam that direction at starting by the lesser weight of the water on that side, due to the lesser hight of the water column. There is another passage from the boiler to the other side of the wheel into which the steam is directed by a valve. When it is desired to stop the wheel, said valve closes the passage. The steam rises against the wheel, and impels it with a force governed by the hight of the water column and the amount of steam generated. In the upper part of water chamber, the steam condenses and flows back into the boiler.

Improved Road Scraper.

James W. Weston, Windsor, Ill., assignor to Turner M. Johnson, of same place.—This invention is a machine for grading roads. The forward ends of a mold board and land side are securely attached to a cast point which is made somewhat like a plow. The lower part of the mold board is faced with a steel plate, which projects beneath the lower edge of the said mold board. By suitable construction, by bearing down upon the rear end of a lever, the forward end of the machine will be raised from the ground for convenience in turning. By lowering the free end of another lever, the rear end of the machine will be raised and supported upon a rear caster wheel. By means of a sharp rimmed guide wheel, the machine may be guided as desired.

Improved Rotary Engine.

Leonard H. Woods, Syracuse, N. Y.—The object of this invention is to produce a rotary engine, which overcomes some of the defects of that class of engines by being built very compactly, having no dead centers, and reversing with perfect ease. The invention consists of the arrangement in an outer steam cylinder with abutments, of a rotating drum on a stationary hollow shaft with steam ports, by which the steam is alternately applied to vibrating gates placed at right angles in the two sections of the drum, and exhausted by suitable ports.

Improved Coffee Pot.

John E. Weber and Peter Knutson, La Crosse, Wis.—The pot is composed of three different sections—the upper or water receptacle, the middle one, into which the gas, alcohol, or coal oil lamp is placed, and the lower receptacle, for the coffee or other articles which are intended to be boiled. The lower part is detachable, and the coffee, tea, etc., placed therein. The upper receptacles is filled with water, closed tightly, and the lamp then lighted. The generation of the steam forces the boiling water up through a tube to a glass bulb, and then, through a smaller tube and strainer, to the lower part, extracting the strength of the coffee. The lamp is then extinguished, and the liquid slowly drawn up again into the water receptacle. The process is repeated, if the coffee is desired to be very strong. The glass bulb or tube indicates, by the passage of the liquid through it, the different stages of the cooking process. The coffee is then drawn off for use.

Improved Heater and Feeder for Boilers.

Garner C. Williams, Catskill, N. Y.—To the feed water pipe, and a certain distance apart, are connected tubes leading from the lower rear portion and from the middle of the under side of the boiler. The water forced along the feed pipe past the junctions with the tubes naturally induces currents from the boiler by the friction of its particles with the particles of the water coming in at the other pipes, which, uniting with the feed water, re-enters the boiler again along with it. To increase this action, a contrivance similar to the head of a steam siphon or injector is arranged in the feed pipe at the point of entry therein of each tube. By this plan, it is claimed that the feed water will be heated nearly to the degree of the water in the boiler, which is much greater than it can be heated by the ordinary feed water heaters.

Improved Steam and Vapor Generator.

Richard Brereton, Easton, Pa., assignor to Benjamin Douglass, Montrose, N. J.—This invention relates to the instantaneous development of steam or vapor from fluid substances by application of the substances to highly heated surfaces in expanders. The essential feature of the invention is a series of hollow spherical balls or expanders, with a feed pipe and jet bulb to each, so arranged that each receives its due measure of feed in such small quantity that the force of the instantaneous expansion is controlled by the balls, and the vapor produced is sent therefrom, along with that from the other balls, to the pipe which conducts it to the engine, in such manner that there is no accumulation anywhere larger than the conducting passage. By this means, it is claimed, the great pressure attainable by the direct contact of the fluid with the red hot metal can be controlled as it could not be in large chambers affording any considerable accumulation. Another feature of the invention is an arrangement of the expansion balls in the furnace so as to be directly surrounded by the fire, to bring the fluid into the most direct contact with the highest heat of the fire

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ANSWERS TO CORRESPONDENTS

We are obliged to J. H. W. for his explanation of the degrees of proof of alcoholic spirit, but the subject is exhausted.—U. U. should consult a maker of hay presses.—F. R. & S. can harden iron mold boards by the processes of case hardening described on p. 362, vol. 25.—T. O. M. will find a good recipe for paste on p. 280, vol. 28. Shaving with pumicestone is described on pp. 149, 180, 281, vol. 26.

T. H. G. asks: When is it winter in Patagonia (Cape Horn) and when is it midwinter there? A. Winter commences on the 21st of June, and it is midwinter in the month of August.

G. M. asks: 1. If a vessel containing 5 cubic feet of compressed air be placed inside of another vessel of 20 cubic feet capacity, and the compressed air be very gradually let into this vessel, with a proper means of escape to prevent an increase of pressure, could a person breathe inside the large vessel? If so, how long would the compressed air supply the necessary amount of air for respiration, the air being compressed to 200 lbs. per square inch? 2. How is gas of ammonia made? A. 1. A person making 15 respirations in a minute would require, under ordinary circumstances, $43 \times 15 = 645$ cubic inches of air. The inner vessel would contain $200 \div 15 \times 5 \times 1728 = 115{,}200$ cubic inches of air at ordinary pressure. Hence the air would support respiration for $115{,}200 \div 645 = 178\frac{26}{43}$ minutes. 2. Put equal weights of quicklime and sal ammoniac, powdered and intimately mixed, in a retort; gently heat it, and an abundance of pure ammonia gas will be given off. An ounce of sal ammoniac will yield about 380 cubic inches of the gas.

C. E. G. asks: How are we to reconcile the conclusions of scientific men in regard to the strength of iron at extremes of temperature? Common observation shows iron to be stronger at a temperature of from 75° to 90° Fah. than at from 25° to 35° below zero. I went to work on a very cold day; the thermometer showed 38° below zero; in attempting to drive a mill dog with a mallet, I broke the dog in two places. The iron showed clean breaks. The rod was one inch square at one break, and ⅞ inch round at the other, parting in both places at the same blow. I tried another dog and struck it into the log with my hand covered by a buckskin mitten. This dog also broke where it was ⅞ inch in diameter. Thinking it dangerous to try to run the saw, we thought we would try to get some stones and ice from the tail race that obstructed the water. I took a common crowbar; and getting a short bite under a stone frozen in, I sprung the bar with my heft, and the bar broke about 6 inches from the fulcrum, showing a perfectly clean break of 1½ inches square iron. Thinking the laws of cohesion had suspended for a time, we suspended operations until a warmer day. This and the facts shown by R. H. Thurston are a paradox. A. The following conclusions, as stated by Professor Thurston in his paper on the "Molecular Changes Produced in Iron by Variations of Temperature," will probably make this matter plain. "10. That the general effect of increase or decrease of temperature is, in solid bodies, to increase their power of resistance to rupture, or to change of form, and their capability of sustaining 'dead' loads. 11. That the general effect of change of temperature is to produce change of ductility, and consequently, change of resilience and power of resisting shocks and of carrying live loads. This change is opposite in direction, and usually greater in degree than the variation simultaneously occurring in tenacity. The practical result of the whole investigation is that iron and copper, and probably other metals, do not lose their power of sustaining 'dead' loads at low temperatures, but they do lose, to a very serious extent, their power of sustaining shocks or resisting sharp blows."

J. M. McG. asks: Will you give me a good plan for steaming and bending plow handles, etc.? What pressure of steam should be used, and how long should they remain in? Is there anything that, if put in the water, will facilitate the softening of the wood? 2. Why were all the American quarter and halves of dollars made in the year 1853 stamped with an imitation of the sun's rays on the eagle side, and none before or since? A. 1. The steam chest for bending timber is commonly made of wood, and connected with the boiler. It is the exposure to the heat of the steam that softens the wood, and probably nothing put into the water will hasten the process. It does not make much difference what pressure of steam is maintained. After the pieces are softened, they are bent to shape, and then, being secured in that position, are placed again in the steam chest, to take a set. 2. Probably because this suited the designer at that period.

C. C. S. asks: 1. What is the length of the Mississippi river from Cairo to New Orleans? 2. What is the speed of the current per hour between these two places? 3. We wish to start from Cairo and go to New Orleans in a small boat. Do you think this is feasible? If not, why? 4. Would the wind aid us in sailing? 5. What size and kind of a boat would you advise us to build? 6. Do you know of any good book describing the Mississippi? A. 1. 1,040 miles. 2. At high water, the velocity is about 2·6 miles per hour; at low water, between 1·5 and 2·1 miles per hour; mean velocity for mean water, 2·26 miles per hour. 3, 4. Yes. 5. Probably it will be best to build a cat-rigged center board boat, from 18 to 20 feet long. 6. There are numerous guide books of the Mississippi, which doubtless contain much that would be interesting and useful to you on your voyage.

C. M. B. asks: 1. What is decalcomania, and how do you "decalc" any thing? 2. Is there any remedy for that every day annoyance, a bad cold in the throat? A. 1. There are various methods of decalcomania or transferring of pictures. The finest is to transfer the pictures on wood. Paper pictures for this purpose are now sold by the stationers. A varnish is applied to the picture only, and it is then pressed on the wood. When dry the paper is dampened and rubbed off with the fingers, leaving the picture on the wood. 2. The way to prevent taking cold is to keep the feet always warm and dry, the chest well protected and to eat plenty of nourishing food. The remedies that have been prescribed for sore throat would fill too much space to be inserted here. Gargling with strong salt water is a good remedy, if used the moment a sensation of soreness is perceived. Singers should wrap the throat up after exercise when going out into the cold air, but at other times the throat should not be too much covered, so as to harden it to the weather. Growing beards is said to be a good preventive against colds in the throat for those who have them to grow.

S. W. asks: How can I run a small bellows without using my hand? A. You might arrange a motion to be worked by your foot.

R. B. S. asks: 1. How can I make a battery that I can silver plate with? Would an ordinary local battery, such as is used in telegraph offices, do? 2. Can you inform me how to clean and polish shells of various kinds? 3. I have tried to make a Hero's fountain, but have not succeeded very well. Suppose I have two tanks, each one holding five gallons, what size should the inside of the tubes connecting them together be? Are all the tubes to be the same size? What hight should the top tank be above the top of the other? A. 1. We think such a battery would answer very well. 2. See p. 132, vol. 27, and use friction for giving a fine polish. 3. Inside diameter of tubes, about one quarter of an inch. All the tubes can be the same size except that you should contract the opening for the jet. Hight of upper vessel below bottom one is regulated by the hight of jet required. From 4 to 5 feet would do very well.

W. P. asks: What is an average analysis of coal? A. Carbon 78·65, hydrogen 4·65, oxygen 14·21, sulphur 0·55, ash (consisting of silica or quartz, oxide of iron, clay, potash, soda) 2·49.

W. S. B. says: 1. I have been told by several mechanics that a block cannot be squared on all sides, that is, that all the sides of a cube, at right angles to each other, cannot be obtained by a common try square. 2. Can a screw be set up tighter with a long screw driver than a short one? What is the theory of this? A. 1. We think a block can be squared on all sides by the use of a carpenter's square, first dressing one face out of wind, and marking a square on it, to serve as a guide in laying off the other faces. 2. The increased inefficiency of a long screw driver is due to the greater leverage afforded by inclining the tool, as already explained on page 393, vol. 18.

R. J. T. asks: Can a locomotive start with more cars, one crank being on the center or dead point, with the other crank below the axle, or above the same? A. There would be no difference in the two cases, except the power required to lift the crank and connecting rod from the lower half center.

E. H. B. asks: What is a remedy for biting the finger nails? A. Keep the fingers out of the mouth. If that fails, wear mittens.

R. H. D. asks: Will the same amount of power exerted on a long screw driver produce a greater effect than on a short one? A. As a matter of fact, it is well known that more effect can be produced with a long screw driver than a short one. See p. 393, vol. 18.

A. D. says: I have a hollow iron cylinder, in which I have made a deep dent. I have tried to fill the dent up by pouring in melted lead, but I could not make the lead to adhere to the iron. How can I make the lead stick? A. You can make the lead adhere by boring holes in the cylinder.

C. D. asks: Why is it that, during rainy weather, when the air is filled with vapor of water, the barometer falls? A. The barometer falls just before stormy weather, because the vapor in the air is condensed, thus lightening the column of air that supports the mercury.

C. J. V. D. says: You say that for casting small articles of iron, plaster of Paris would be better than clay. Will it also do for brass, for articles 6 or 8 ozs. in weight? Would vent holes be needed for the escape of gas? A. We think that plaster of Paris would answer in the cases mentioned, if proper vent holes were provided.

P. G. K. asks: Is it precisely 12 o'clock, noon, at any given point when the sun is due south of that point? Does it vary? If so, what is the variation? When is the sun due south of San Francisco at noon? A. It is precisely noon under these circumstances at four times in the year, about December 25, April 16, June 16, and September 1. At all other times the noon time, as shown by the sun, must be corrected by the equation of time, which is given in the Nautical Almanac for every day of each year. In answer to your other query, consult a lawyer.

J. R. asks: Where should the draw bar of a locomotive be attached? If above the center, she will tip up in front, vertically. A. As low down as possible.

R. M. S. asks: 1. What is gasoline composed of? 2. Is it more dangerous to burn than common coal oil? If so, why? 3. What are naphtha and benzine composed of? A. 1. The term gasoline is a barbarism applied to highly rectified naphtha, one of the liquid hydrocarbons distilled from petroleum. 2. It is extremely dangerous to attempt to burn it in the ordinary manner, on account of its volatility, the combustibility of its vapor, and its explosiveness when mingled with the air. 3. Naphtha and benzine are two names for the same thing. They are compounds of hydrogen and carbon. We do not know the other fluids you mention.

J. F. A. asks: What proportions of carbonate of soda and sulphuric acid, each in solution of equal quantities of water, will generate the best quality of carbonic acid gas for extinguishing fires? A. The quality of the carbonic acid gas will not be affected by varying the proportions or the strength of the solutions employed.

L. H. D. asks: 1. How can I make a gold wash? 2. How can I mold hard rubber, so that it shall retain its elasticity? A. 1. You can make a gold wash as follows: Dissolve 1 part of gold in 3 parts of nitro-muriatic acid (a mixture of nitric and muriatic acids) evaporate until vapors of chlorine cease to be evolved, and then set the solution aside to crystalize. Dissolve the crystals, which are the terchloride of gold, in water. To the solution add ether and shake the two together for some time. Finally pour off the upper portion, which is an ethereal solution of gold. When this is applied with a camel's hair brush to polished iron or steel, the ether soon evaporates and leaves the surface covered with a film of pure gold. In this way any fancy device or writing may be executed with facility. 2. When rubber is melted it does not readily again become solid. Your best plan is to immerse the rubber in a mixture of bisulphuret of carbon 95 parts, and rectified alcohol 5 parts, until it swells into a pasty mass, which may then be molded into any desired form.

J. A. E. asks: Can you give me any information respecting the merits of the Vera Cruz cement, used by the Mexicans for building purposes? 2. How can I construct a cheap home made telescope? A. 1. It is very highly spoken of by engineers who have made experiments to determine its qualities. 2. See p. 7, vol. 30.

F. T. H. says: In trying to make gun cotton, I took a handful of cotton and poured upon it one ounce of nitric and one half ounce of sulphuric acids, mixed well, and allowed to cool before pouring. After allowing my cotton to remain in this solution 10 or 15 minutes, I removed it and washed it until the cotton did not have any chemical effect on blue litmus paper. I then dried and ignited it, but it burnt only as common cotton would do. A. Your acids were not in the proper proportions and probably not strong enough. Treat as follows: Mix together equal measures of concentrated nitric acid (S. G. 1·5) and concentrated sulphuric acid (S. G. 1·845). When cool, pour into a glass vessel and immerse in it clean dry carded cotton, in as loose a state as possible, for 4 or 5 minutes, promoting the action of the liquid by stirring with a glass rod. Then pour the acids off and squeeze the cotton as dry as possible, by means of the glass rod, or between plates. Then throw the cotton into clean soft water, as large a quantity as practicable, squeeze dry again, and then wash in a stream of water until the article is perfectly free from acid. Lastly dry by a steam bath at about 180° Fah. Only small quantities of cotton should be prepared at a time, and the greatest caution observed in handling after manufacture. Good gun cotton explodes at 300° Fah., without either smoke or residue.

S. A. B. says: I am told that nitrogen may be formed by fabricating coke. Will you explain this? Does it mean that coking the coal accomplishes it, and can it be done in open air? 2. How much nitrate of potassa will be sufficient to put in a tun of fertilizer? A. 1. There is no free nitrogen formed in the destructive distillation of coal. A ready means on the small scale of obtaining nitrogen is to burn up the oxygen, in a bell glass filled with air, over water, by means of phosphorus. 2. Dr. Jeannel's fertilizer (see p. 401, vol. 28) contains 25 per cent nitrate of potash.

J. M. says: I have a plain cylinder boiler 16 feet long. The fire goes under it and up the smoke stack. Would a check wall built at the far end of boiler save fuel? A. We do not think the proposed arrangement will prove efficient.

A. K. asks: 1. What fish swims the fastest, and where could I see a good drawing of the same? 2. What is the name of the fluid which removes all dirt from the works of a watch by immersion? A. 1. Either the sword fish or tunny. You will find them illustrated in almost any good encyclopedia. 2. See p. 98 of our vol. 26.

R. T. asks: How can I make a filling for walnut wood, that will take varnish well? A. Mix with good whiting such colors as will produce the desired hue. Give the wood a good coat of oil, and sprinkle the mixture over the work until it is pretty well covered, then rub in well with a soft rag. Wipe off the superfluous filling, let dry, and varnish.

MINERALS, ETC.—Specimens have been received from the following correspondents, and examined with the results stated:

S. S. S.—This is a fine specimen of micaceous oxide of iron. It is often found in connection with common specular iron, but rarely in sufficient quantities to be explored by itself.

N. R. T. Jr.—1. Copper pyrites, a compound of copper, iron, and sulphur. 2. Quartz conglomerate. 3. Iron pyrites in quartz. 4. Red oxide of zinc and magnetic iron.

W. H. H.—This mineral is a compact brown oxide of iron.

E. E. B.—1. Clay with oxide of iron. 2. Clay containing brown oxide of iron. 3. Brown quartz.

D. McD.—Your mineral is shale, and its presence is considered a strong indication of coal in the vicinity. The bituminous variety, however, is more closely connected with coal. The presence of bitumen may be easily determined by the smell, after heating for a moment in the flame of a lamp.

W. S.—Your mineral is bog iron ore, a variety of brown oxide of iron. Bog iron ore generally yields about 30 of 35 per cent of cast iron; but on account of its containing a small proportion of phosphoric acid, the bar iron made from it is often more or less "cold short." It is advantageously smelted with the brown oxide and other ores of iron.

Josiah M. Hess, 292 East Washington street, Indianapolis, Ind., wishes to know who makes the best horse radish grater. Will some correspondent inform him?

COMMUNICATIONS RECEIVED.

The Editor of the SCIENTIFIC AMERICAN acknowledges, with much pleasure, the receipt of original papers and contributions upon the following subjects:

On Photographs of the Invisible. By J. H.

On an Aerial Ship. By W. O.

On What to Do in Hard Times. By G. E. and by J. P. A.

On the Ventilation of the Senate Chamber. By R. T. C.

On Small Steamers. By G. S. C.

On a New Means of Producing Fire. By C. C. A.

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On Administrative Reform in the Patent Office. By G. R.

On Some New Inventions. By C. W. P.

On an Instance of Atmospheric Refraction. By T. H.

On the Alignment of the Hoosac Tunnel. By C. F.

On a Total Eclipse of the Moon. By J. M. B.

Also enquiries from the following:

F. S. L.—D. C. T.—K. A. H.—H. M. P.—G. W. K.

Correspondents in different parts of the country ask Who makes steam fire engines? Who makes a pie lifter, of copper wire? Who sells knitting machines? Where can machinery for light cooper's work be obtained? Makers of the above articles will probably promote their interests by advertising, in reply, in the SCIENTIFIC AMERICAN.

Correspondents who write to ask the address of certain manufacturers, or where specified articles are to be had, also those having goods for sale, or who want to find partners, should send with their communications an amount sufficient to cover the cost of publication under the head of "Business and Personal" which is specially devoted to such enquiries.

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Tobacco stripping machine, Tunnicliff *et al*..... 145,699
Tongs, culinary, A. Greenleaf..... 145,564
Trap, fly, T. Lane..... 145,707
Tree protector, J. Neff..... 145,585
Urn, coffee, C. Hitchcock..... 145,653
Vault cover, W. Dale, (r)..... 5,684
Wagon standard, C. W. Saladee..... 145,594
Washing machine, Tull & Weston..... 145,602
Watch chain, Frontier & Bellemere..... 145,642
Water closet, J. F. Neilson..... 145,586
Way, elevated, H. W. Farley..... 145,638
Weather strip, O. W. Booth..... 145,616
Whalebone or rattan, splitting, J. Taggart..... 145,539
Wheel, buffing, E. & W. Dixon..... 145,492
Windmill, J. A. Wheeler..... 145,541
Window blind slat adjuster, Beach & Berry..... 145,481
Window screen, W. G. Anderson..... 145,517
Wrench, S. J. Wright..... 145,710

APPLICATIONS FOR EXTENSIONS.

Applications have been duly filed and are now pending for the extension of the following Letters Patent. Hearings upon the respective applications are appointed for the days hereinafter mentioned:

27,627.—CULTIVATOR.—C. M. Hall, D. E. Hall. March 11.
27,641.—HARVESTER.—F. T. Lomont *et al*. March 11.
27,743.—BOILER FEED.—T. Snowdon. March 18.
28, 04.—CAR AXLE.—J. Montgomery. March 8.
28,263.—BAYONET SCABBARD.—E. Gaylord. April 29.

EXTENSIONS GRANTED.

26,475.—BREECH LOADING FIRE ARM.—B. Burton.
26,484.—PLATFORM SCALE —T. Fairbanks.
26,485.—PIPE MOLDING.—J. Firth, J. Ingham.
26,487.—SCREW TAPS.—W. and Robert Foster.
26,506.—WATER TRAP.—J. A. Lowe.

DISCLAIMER.

27,475.—BREECH LOADING FIRE ARM.—B. Burton.

DESIGNS PATENTED.

7,049 —LAMP PEDESTAL —N. L. Bradley, W. Meriden, Ct.
7,050.—CARPETS.—J. Fisher, Enfield, Conn.
7,051 to 7,059.—CARPETS.—O. Heinigke, New York city.
7,060 & 7,061.—CARPETS.—H Horan, East Orange, N. J.
7,062.—SHOW CASES.—J. Irons, Philadelphia, Pa.
7,063.—SODA WATER APPARATUS.—G. F. Meacham, Newton, Mass.
7,064.—FUR TRIMMING.—A. Molnar, New York city.
7,065 & 7,066.—CARPETS.—J. H. Smith, Enfield, Conn.
7,067.—TABLE CASTER HANDLES.—H. C. Wilcox, West Meriden, Conn.

TRADE MARKS REGISTERED.

1,574.—COMPOSITION GOODS.—Greanelle Manu. Co., New York city.
1,575.—BURNING FLUIDS, ETC.—Netterfield *et al*., Burr Oak, Mich.
1,576.—WHISKY.—D. Porter, San Francisco, Cal.
1,577.—PERFUMES, ETC.—G. J. Wenck, New York city.

SCHEDULE OF PATENT FEES.

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On appeal to Commissioner of Patents..... **$20**
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On application for Extension of Patent..... **$50**
On granting the Extension..... **$50**
On filing a Disclaimer..... **$10**
On an application for Design (3½ years)..... **$10**
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On application for Design (14 years)..... **$30**

[Specially reported for the Scientific American.]

CANADIAN PATENTS.

LIST OF PATENTS GRANTED IN CANADA DECEMBER 23 TO DECEMBER 29, 1873.

2,950.—W. A. Weldon and J. S. Dennis, Chicago, Ill., U. S Improvements on curtain fixtures, called "The Weldon Curtain Fixture." Dec. 23, 1873.

2,951.—W. A. Lyttle, Grove, Hammersmith, Middlesex county, Eng. Improved process for preserving timber, called "Lyttle's Process for Preserving Timber." Dec. 23, 1873.

2,952.—I. S. Russell, New Market, Md., U. S., and H. R. Russell, Woodbury, N. J., U. S. Improvements in earth closets, called "Russell's Earth Closet." Dec. 29, 1873.

2,953.—J. G. Tourangeau, Quebec, P. Q. *Machine pour faire la pate*, called "*Le Petrin Tourangeau*." "A Dough Making Machine." Dec. 29, 1873.

2,954 —I. Kinney, London, Middlesex county, Ontario. Machine for designing and cutting scrolls and curved lines more accurately and expeditiously than has heretofore been done, called "Kinney's Instrument for Designing and Cutting Scrolls and Curved Lines." Dec. 29, 1873.

2,955.—P. English, Hamilton, Ontario. Improvements in rotary steam engines, called "English's Improved Rotary Steam Engine." Dec. 29, 1873.

2,956.—C. W. Jenks, Somerville, Mass., U. S. Improvement on skirts, called "The Sanspareil Skirt." Dec. 29, 1873.

2,957.—C. P. Leavitt, New York city, U. S. Improvement on hot air engines, called "Leavitt's Hot Air Engine." Dec. 29, 1873.

2,958.—J. F. Stairs, Halifax, Nova Scotia. Improvements in the art or process of preparing oakum, called "Stairs' Improved Oakum." Dec. 29, 1873.

2,959.—J. F. Stairs, Halifax, Nova Scotia. Improvements in tarring tow and oakum, called "Stairs' Improved Oakum Machine." Dec. 29, 1873.

2,960.—S. Smyth, Bridgewater, Susquehanna county, Pa., U. S. Improvements in grates for stoves and furnaces, called "Smyth's Stove and Furnace Grate." Dec. 29, 1873.

2,961.—F. J. Bowles, London, Middlesex, Ontario, assignee of J. H. Thorp, Chicago, Ill. Machine for the detection of burglars, being a portable burglar alarm, called "Bowles' Improved Portable Burglar Alarm." Dec. 29, 1873.

2,962.—J. Lanham, London, Eng. Improvements in the manufacture of boots and shoes and apparatus therefor, called "Lanham's Boots and Shoes, Heel Press and Last." Dec. 29, 1873.

2,963.—J. B. Pugh, Champaign, Champaign county, Ill., U. S. Improvements on hay presses, called "Pugh's Champion Double Press." Dec. 29, 1873.

2,964.—A. D. Crosby, Cuba, Alleghany, Pa., U. S. Improvements in buckets for chain pumps, called "Crosby's Improved Bucket for Chain Pumps." Dec. 29 1873.

2,965.—B. Morton and J. L. Smith, Toronto, Ontario Improvements on snow plows, called "Morton and Smiths. Improved Snow Plow." Dec. 29, 1873.

2,966.—T R Way, Springfield Clark county, O., U. S. Improvements on millstone picks, called "Way's Eccentric Mill Pick." Dec. 29, 1873.

HOW TO OBTAIN

Patents and Caveats

IN CANADA.

PATENTS are now granted to inventors in Canada, without distinction as to the nationality of the applicant. The proceedings to obtain patents in Canada are nearly the same as in the United States. The applicant is required to furnish a model, with specification and drawings in duplicate. It is also necessary for him to sign and make affidavit to the originality of the invention.

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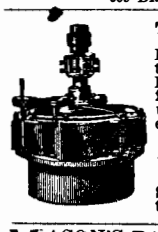

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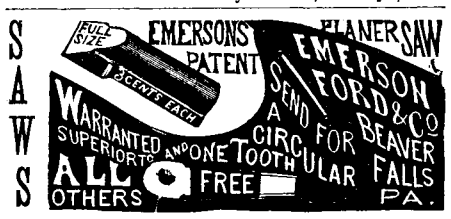

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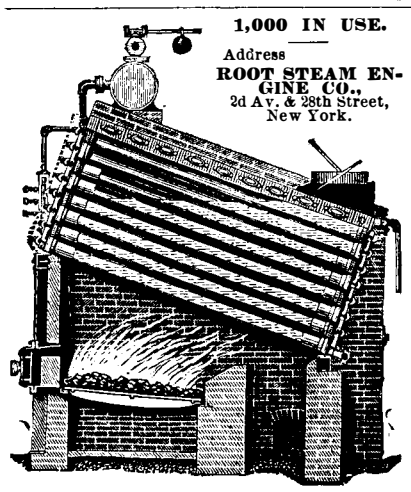

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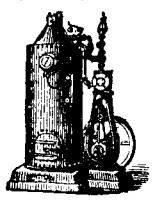

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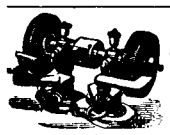

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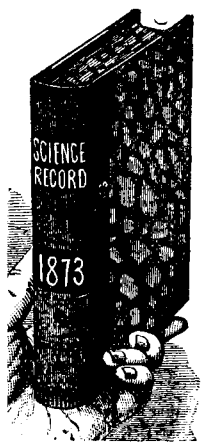

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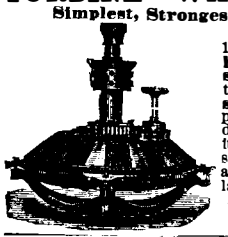

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